SPACE ORDNANCE SYSTEMS, INC.

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FINAL REPORT

FOR

DEVELOPMENT OF AN ENVIRONMENTALLY IMMUNE ELECTROSTATIC INSENSITIVE APOLLO STANDARD INITIATOR

NAS9-4147

SPACE ORDNANCE SYSTEMS, INC.

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I ABSTRACT

As a result of the excellent static discharge resistance of the Apollo Standard Initiator at a one (1) atmosphere condition and considering the potentially high static electrofication possibilities of spacecraft, Space Ordnance proposed that a development program to provide the same level of electro-static discharge protection in deep space be conducted.

In addition, the intent of the program was to develop test techniques which will assure that the electro-static discharge will not degrade the initiation mix.

Four (4) of the seven (7) initially proposed concepts have shown that additional protection with respect to inadvertant firing as a result of high static voltage pulses, has been increased. However, none of these concepts have provided protection with respect to changes in interbridge characteristics of the initiation mix. All post-pulse electrical tests were conducted at sea level conditions.

General testing with respect to various electro-static pulse tests on initiation charge pellets outside of the initiator has been conducted, and a considerable amount of additional information in this area has been obtained. (Refer to General Testing Section of this report.)

II INTRODUCTION

An environmentally immune electrostatic insensitive Apollo Standard Initiator is being developed under NASA Contract No. NAS9-4147, under the cognizance of the NASA Manned Spacecraft Center, Houston, Texas.

Six design concepts have been tested for static discharge susceptibility at standard pressure and temperature and at a vacuum of 10^{-6} torr.

The goal of this program is to achieve a design that will not change electrical characteristics or fire inadvertantly as a result of static discharge from a 500 pico-farad capacitor charged to 30,000 volts dc whether at a sea level environment or in outer space.

Two basic methods have been evaluated:

1. The encapsulation of a spark gap in a controlled atmosphere

2. The use of solid state techniques

III CONCLUSIONS

Testing conducted under this program has shown that both solid state and spark gap encapsulation techniques do provide environmentally immune electrostatic discharge properties.

Testing completed on six (6) concepts, three (3) utilizing encapsulation techniques, one (1) utilizing solid state techniques, one (1) utilizing an internal faraday shield, and one (1) utilizing an encapsulated spark gap in conjunction with the internal faraday shield produced the following results.

Each of the spark gap encapsulation methods improved the high voltage withstanding properties in one atmosphere and deep space environments. Solid state techniques utilizing General Electric Thyrite Varistor material also produced positive results with respect to high voltage withstanding capabilities; however, varistor materials which will meet the insulation resistance and dielectric strength requirements of the initiator are not available.

Units utilizing the internal faraday shield, and a spark gap in conjunction with a faraday shield produced negative results and no further consideration of these concepts are recommended.

Although spark gap encapsulation and solid state techniques do improve voltage withstanding capabilities, no method tested provided protection with respect to changes in interbridge resistance and capacitance.

As a result of the negative data, with respect to interbridge characteristic changes, testing was conducted in the following areas:

1. Spark gap breakdown reproducibility.
2. Surge voltages.
3. Initiation charge pellet investigation.

Spark gap investigations showed that a given gap produced voltage breakdown levels which varied a maximum of plus or minus twenty percent.

Testing has shown that surge voltages are present at the initiation charge side of the header. This condition was demonstrated by providing one spark gap on a pin header assembly on the connector end and recording voltage differentials between the pin with the spark gap and the pin without. A differential of 500 to 550 volts was indicated. Efforts to record these surge voltages across an initiator spark gap were unsuccessful due to required recording speed and different breakdown times. As a result, no test data in this area is available. However, it is reasonable to assume that if 500 volt surges are experienced on units with very small spark gaps, surges approaching the applied voltage are possible on units with a larger spark gap. Therefore, breakdown voltages seen during static pulsing are not indicative of what the initiation charge pellet is seeing.

Testing has shown that a pellet of initiation charge, when supported between two sharp .03 radii probes, looses its resistance characteristics when pulsed at voltage levels of 300 to 500 VDC. Testing following slight movements of the pellet, thereby changing the point of contact, which has changed its resistance characteristics have produced resistance readings of a non-pulsed pellet. This data verifies that the indicated changes are only with respect to a minute path through the pellet and is not indicative of an overall change in the pellet resistance.

Tests were conducted to determine which element of the SOS-108 mix was being affected. This was accomplished by blending special mixes omitting specified elements in each mix. Testing indicated that no single element is being affected and that the experienced changes occurred only on the complete composition.

Testing was conducted utilizing four (4) neon bulbs in series with each of the firing leads. These bulbs ionized and passed voltage to ground at between 70 and 100 volts. Units tested still evidenced changes in interbridge characteristics. However, after short periods at laboratory ambient conditions, interbridge characteristics returned to their original state.

In an effort to reduce voltage surges, choke coils were installed in series with each circuit. Units tested in this manner changed characteristics as before.

Investigations, with respect to methods of restoring interbridge characteristics, have been conducted. Initial results indicated that interbridge characteristics were restored to original state after being subjected to a temperature of 300°F. Initial results were obtained after the unit had been removed from the heating chamber and stabilized at room temperature. Subsequent testing has negated initial results. A unit which had not been electrostatically pulsed, AIRME reading of less than 1.00 circuit to circuit, was placed in the temperature chamber at 300°F. Interbridge characteristics were monitored as the units' temperature increased. After approximately five minutes, the resistance circuit to circuit was +4.0. Upon cooling, this reading reduced to its original level. This testing was also conducted on pulsed units. Interbridge characteristics on these units returned to less than 1.00 after approximately one minute in the temperature chamber. However, after approximately two minutes, the interbridge characteristics were again greater than 1.00. When allowed to cool, these characteristics returned to less than 1.00.

Testing has shown that the phenomenon of interbridge resistance and capacitance changes are, most likely, a result of any one or a combination of the following:

A. Current flow through the mix.

B. As a result of current flow and the associated heat, a localized change in mix structure occurs.

C. A dielectric puncture of the binder.

D. A sensitizing or polarization of the metal particles.

IV RECOMMENDATIONS

Testing conducted on this program has shown that a number of the concepts tested will provide high voltage withstanding capabilities. After evaluating both test results and production feasibility, it is recommended that Concept "C" be considered by NASA engineering. However, since no concept corrected the changes in inter-bridge characteristics and since the initiator is energized only on one circuit, it is also recommended that serious consideration be given to a two-pin, single bridgewire Apollo Standard Initiator.

It is to be noted that Concept "C" can be incorporated in the two-pin unit to provide an environmentally immune electrostatic insensitive initiator.

V DISCUSSION OF CONCEPTS

1.0 CONCEPT A

This concept was proposed as an initial feasibility study of the controlled gas encapsulation approach. However, this concept was deleted from the program and replaced by Concept H.

1.1 CONCEPT B

This concept, as proposed, was similar to Concept A with the exception that a ceramic disk hermetically sealed, by means of soldering and/or brazing was to be utilized rather than the isomica disk environmentally sealed with epoxy.

Great difficulty was encountered in obtaining a simultaneous hermetic seal around the pin header assembly, the alumina disk and the four pins. In all cases where the hermetic seal was obtained, the spark gap was found to be shorted to the pins of the header. Utilization of different temperature solders and closer mating surface central did not provide a solution.

During discussions of these problems with the cognizant NASA engineer, it was decided that fabrication of the units would be accomplished using epoxy for sealing the ceramic disk. Refer to revised concept drawing. After the unit was completely fabricated, the gas plenum around the spark gap was tested for seal integrity by placing the units in a vacuum chamber, reducing and maintaining the pressure at one inch Hg absolute (minimum) for 25 minutes minimum. The chamber was then filled and pressurized with helium to 15 psig. After a 5-minute minimum soak at 15 psig, the units were removed and checked on a Veeco Leak Detector. All units tested under vacuum conditions had a leakage rate of less than 1×10^{-6} cc He/Sec.

All units tested had been potted with SOS-100 Compound followed by removal of the connector end.

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1.1.1 TEST RESULTS

Units 05, 06 and 07 were pulsed at the sea level condition. An anomaly occurred between the first and second pulsing of the above units.

On 7/27, these units were pulsed with 25,000 volts dc. Post pulsing electrical testing indicates that as before, interbridge resistance measured between Circuits A-B and C-D, readings changed from less than 1.000 to above 4.0 on the AERMI. However, the units were re-tested on 7/28 prior to the second static pulse and the interbridge readings had reverted to less than 1.00. During subsequent pulsing, these values fluctuated between above 4.0 and below 1.00. It is to be noted that these results were only obtained on the above units.

Vacuum testing of the remaining units Serial Nos. 02, 03 and 04 produced the following results. Unit 02 fired with the first static pulse. A breakdown voltage of 2020 volts was indicated on the unit. The remaining units did not fire after being subjected to five pulses at the 25,000 volt level. However, after two pulses, no interbridge capacitance reading could be obtained on Unit 03. After five pulses, the interbridge resistance of this unit was measured on a Cubic Digital Ohmmeter and found to be 248.1 ohms.

1.1.2 CONCLUSIONS

This concept does provide additional protection for units being statically pulsed under vacuum conditions. However, this protection is only with respect to firing of the unit. The interbridge characteristics of the unit still change.

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1.2 CONCEPT C

This concept permitted the use of standard components now being used to produce the Apollo Standard Initiator. The following modifications were made on the header assembly prior to installation in the initiator body. An angular groove .012-.015 inches wide by .030-.032 inches deep was ground around the outside diameter of the header. This groove exposed the .020 diameter portion of the Kovar pins. Four short pieces of stainless steel wire were placed between the four pins to act as a support and provide proper discharge gap between each pin and another piece of stainless steel wire which was placed on top of the four pieces. The latter wire formed a 360° ring around the header and was sealed in place with a Du Pont conductive silver preparation No. 5504A to prevent solder from entering the discharge cap.

During the first pulsing of units, it was observed that there appeared to be an arcing between the connector and the initiator case. Testing of the ASI standard pulsing connector indicated that the connector insulation broke down between 9,000 and 10,000 volts dc. Subsequent testing of a modified Bendix connector showed that this Bendix connector would withstand 14,000-15,000 volts dc before breakdown occurred. Further investigation showed that arcing between the connector and the initiator body occurred between 1,500 and 2,000 volts dc. Based on the above results, Space Ordnance contacted the cognizant NASA engineer and requested that we be allowed to pot the connector end of the initiator with an insulating compound and then remove the connector end just behind the hex portion of the body, thus providing in insulation barrier which would have forced the applied voltage through the spark gap. This approval was received. (Refer to Modified Concept Configuration Drawing in Appendix.)

1.2.1 TEST RESULTS

Units 01, 02 and 03 were initially pulsed at sea level condition, with 25,000 volts dc before the initiators and connectors were modified. Unit 03 fired when this pulse was applied. The remaining units did not fire; however, interbridge resistance changed to a reading above 4.0 on the AIRME for both units. Unit 02 fired during the second pulse with a breakdown voltage of 2,020 volts. Unit 01 withstood five (5) static pulses without firing. Significant changes in both interbridge resistance and capacitance occurred. Interbridge resistance changed from less than .100 to greater than 4.0 on the AIRME after the initial pulse and interbridge capacitance changed from 2.3 pf to 42.7 pf after five (5) pulses.

Units 05, 06 and 07 all fired with the first pulse of 25,000 volts. These units showed voltage breakdown levels of 2,820, 2,700 and 3,100 volts respectively.

1.2.2 CONCLUSIONS AND RECOMMENDATIONS

The initial testing of this concept produced only negative results. However, during discussions with NASA personnel, it was decided that seven additional units would be fabricated and tested. These units were manufactured in the same manner as the initial units; however, the exposed portion of each .020 diameter pin in the angular groove was formed, by staking, into a sharp point which would provide a sharp surface for the pulse to discharge through.

These additional units have been tested, and the results are as follows:

Unit Serial No. 08 withstood five (5) pulses of 25,000 volts without firing. Current leakage between shorted pins and case increased from one (1) micro amp at 500 VAC prior to pulsing to greater than 100 micro amps at 400 volts ac after pulsing. Interbridge resistance changed from an initial level of .072 to greater than 4.0 on the AIRME after the first application of voltage. Breakdown voltages ranged from 1,900 volts maximum to 650 volts minimum. The unit was pulsed while being maintained at a vacuum level of 1 x 10^{-6} mm/Hg.

Unit Serial Nos. 011, 012 and 014 also withstood five (5) pulses of 25,000 volts without firing. However, each unit changed interbridge resistance from less than .100 on the AIRME prior to initial pulsing to greater than 4.0 after pulsing. Interbridge capacitance and pin to case capacitance increased with successive pulses. Breakdown voltages on these units ranged from a maximum of 2,450 volts to a minimum of 1,050 volts. These units had also been conditioned at a vacuum of 1 x 10^{-6} mm/Hg.

Unit Serial No. 013 was subjected to and fired during the first application of 25,000 volts.

Unit Serial No. 016 was subjected to, and passed without firing, five (5) pulses of 25,000 volts. Interbridge resistance again changed from less than .100 on the AIRME to greater than 4.0 following first static pulse. Interbridge capacitance and pin to case capacitance increased with successive pulsing. Spark gap breakdown occurred between 2,025 volts maximum and 1,700 volts minimum.

1.2.3 <u>CONCLUSIONS</u>

Additional testing completed on Concept C, which provided a sharp point for voltage breakdown, has shown that this concept does provide additional protection for units being statically pulsed either at sea level or vacuum conditions. However, this protection is only with respect to firing of the unit. The interbridge characteristics, such as interbridge resistance (Circuits A-B to C-D), interbridge capacitance at one (1) megacycle (Circuits A-B to C-D), and pin to case capacitance at one (1) megacycle (shorted pins to case) are still affected by pulsing at high voltage levels.

1.3 CONCEPT D

This concept utilized a cross configuration (See Concept D Revised Illustration in Appendix.). This configuration was produced by initially metallizing the ceramic slug, prior to brazing of the contact pins, over its entire outer surface. Following metallizing, a path was ground across the pin hole surfaces which provided a .010 gap between the contact pins and the metallized surface of the header assembly.

The header spark gap was environmentally sealed in the same manner as Concept B.

1.3.1 TEST RESULTS

A total of six (6) of these units have been tested.

Unit Serial Nos. 08 and 03 were subjected to five (5) successive pulses of 25,000 volts. Both units had current leakage between shorted pins and case in excess of 100 micro amps at voltage levels of 200 and 400 volts ac respectively prior to initial pulsing. Following initial pulsing of 25,000 volts, neither unit exhibited interbridge resistance characteristics in excess of 1.0 on the AIRME; however, both units exhibited a current leakage of more than 100 micro amps at 10 volts ac following initial pulsing.

Following a second pulse of 25,000 volts, both units show a shift in interbridge characteristics in excess of 1.0 on the AIRME. Interbridge and pin to case capacitance at one (1) megacycle increased with successive pulsing on both units. Dissection of the units following testing showed that the resistance breakdown when the unit was subjected to 500 volts ac and 500 volts dc did not occur across the spark gap.

Units 02, 04, 05 and 07 were subjected to voltage pulses while being subjected to a vacuum level of 1 x 10^{-6} mm/Hg. None of these units fired as a result of high voltage application.

Units 02, 04 and 05 retained interbridge characteristics after being subjected to one (1) 25,000 volt pulse. Interbridge resistance on these units, although changing, did not change to the extent of previous units; that is, the change was not in excess of 1.0 on the AIRME.

After three (3) applications of 25,000 volts, Unit Serial No. 02 showed an interbridge resistance between Circuits A-B and C-D of 1.5 on the AIRME. Subsequent pulsing and testing produced interbridge resistance readings of less than 1.0; that is, .175 and .096 on the AIRME.

Unit Serial No. 04 withstood three (3) pulses of 25,000 volts before interbridge resistance changed to a level greater than 4.0 on the AIRME.

Unit Serial No. 05 withstood one (1) pulse before interbridge resistance exceeded 4.0 on the AIRME. In all cases, interbridge capacitance and pin to case

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capacitance increased with successive pulses.

Breakdown voltages across the internal spark gap of the units conditioned at 1 x 10^{-6} mm/Hg were a maximum of 1,775 volts and the minimum of 700 volts.

1.3.2 CONCLUSIONS

As with previous concepts tested, Concept D test results indicate that additional protection, with respect to inadvertant firing caused by high voltage static pulses, has been provided. However, this protection is only with respect to firing of the unit. The interbridge characteristics of the unit still change.

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1.4 CONCEPT E

This concept was predicated on the use of General Electric Thyrite varistor material. This is a non-linear material whose electrical characteristics are such that the current flow increases as a direct power of the applied voltage. That is, the resistance of the material drops sharply as the voltage across the mass is increased.

Prior to fabrication of units per Concepts E and F, it was believed that a preliminary investigation of standard varistors was necessary. This test data is presented in Table II of the Appendix. During these tests, each of three (3) possible failure modes were isolated with the varistor installed only in the circuit in question and the static discharge applied to that circuit. The circuits isolated and tested were Pin A to case, Pins A to B, and Pins B to C. In order to isolate each mode, leads were attached to specific pins, and the connector end was potted with insulating material.

1.4.1 PRELIMINARY TEST RESULTS

Preliminary testing indicated that the varistor material in series with the initiator circuit did, in fact, improve the ability of the initiator to withstand high voltage pulses without firing.

Initial testing did show that the initiators with varistors, in series with specific tests circuits, did more reliably withstand high voltage electro-static pulses.

However, it was found that the disc material would not provide the other necessary electrical characteristics; that is, insulation resistance at 500 volts dc, dielectric strength at 500 volts ac.

The test results recorded in Table I for Concept E were conducted to determine the degree of protection and the electrical characteristics that could be obtained utilizing existing varistor materials. These tests, therefore, are of an investigative nature and are presented only for evaluation of the feasibility of using varistor materials in the initiator. It is to be noted in both insulation resistance and dielectric strength testing that in most cases the 500 volt level was not obtainable due either to low resistance of the material or high rate of current leakage upon applied voltage. Therefore, the readings obtained and recorded, in most cases, do not meet the specification requirements of the Apollo Standard Initiator. It is to be noted, also, that no units fired as a result of static pulsing. All units were tested either at sea level conditions or at a 1×10^{-6} mm Hg deep space environment.

1.5 CONCEPT F

This concept was discontinued until the results of Concept E were evaluated. Following the outline tests of Concept E, This concept has been discarded.

1.6 CONCEPT G

This concept utilized the Faraday shield. No static gap was provided in this concept. Three units were pulsed with 25,000 volts dc, and all three fired on the first pulse. Therefore, this concept has been abandoned and no further testing is scheduled.

1.7 CONCEPT H

As previously stated, this concept replaced Concept A. This concept utilized the Faraday shield of Concept G in conjunction with the encapsulated spark gap of Concept B. As with Concept G, testing proved negative. Two units were pulsed at the 25,000 volt level and both fired. Pulse voltage was reduced to 9,000 volts, and an additional unit was tested. This unit also fired. Testing was stopped and no further tests will be conducted on this concept.

2.0 TESTING SEQUENCE AND PROCEDURE

Prior to and following each static pulse, the following tests were conducted. All electrical tests were conducted at the sea level condition and ambient temperatures.

2.1 INSULATION RESISTANCE

The resistance between the shorted initiator terminals and the body of the initiator was measured on each unit by applying 500 $\pm$25 volts dc for 60 $\pm$5 seconds using a megohmmeter. The test setup used was similar to the one shown in Figure I.

2.2 BRIDGEWIRE RESISTANCE

The resistance of the internal circuits of each unit was measured and recorded while installed in a test setup similar to the one shown in Figure II. The resistance values were measured with a Cubic Digital Ohmmeter (I = 0.014 amps maximum).

2.3 DIELECTRIC STRENGTH

Each unit was installed in a test setup similar to the one shown in Figure III and placed in a safety enclosure. They were then subjected to a 500 volt rms 60 cps test potential applied between all shorted pins to case for a period of one minute. The leakage current was measured throughout the one-minute period. The leakage of each specimen was recorded at the end of the one-minute period.

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2.4 INTERBRIDGE CAPACITANCE

See Figure IV.

2.5 PIN TO CASE CAPACITANCE

See Figure V.

2.6 ELECTROSTATIC SENSITIVITY TEST

Each unit was placed in a protective enclosure and connected to a test circuit similar to the one shown in Figure VI. A 500 pica-farad capacitance was charged to a specified voltage and discharged between the shorted bridgewire pins and the initiator case.

2.7 VACUUM TESTING

Those units which were tested under vacuum conditions were placed in the vacuum chamber and conditioned at 1×10^{-6} mm Hg for a period of 15 minutes minimum prior to electrostatic pulsing. Following pulsing, the units were returned to sea level conditions, removed from the vacuum chamber and the characteristics re-tested, replaced in the chamber and re-tested.

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3.0 GENERAL TESTING

3.1 STANDARD UNITS

Prior to testing of these concepts, seven SO1-266-3 Initiators were subjected to the outlined testing sequence and procedure.

Static pulsing of units 0006, 0211 and 0013 was conducted at sea level with an initial pulse of 9,000 volts. The voltage level was raised in 3,000 volts increments until the unit either fired or reached 30,000 volts, this level being equipment limited.

Unit Serial No. 0006 had been rejected in final lot acceptance for high bridgewire resistance on Circuit A-B. The remaining characteristics were per specification. Upon pulsing at 9,000 volts, the interbridge resistance changed from .110 to 4.446 on the AERMI, interbridge capacitance changed from 3.4 pf to 6.2 pf. Pin to case capacitance changed from 11.0 pf to 11.7 pf. Breakdown voltage recorded was 620 volts. Subsequent pulsing at higher levels produced slight changes in the above characteristics. After the fourth pulse, the connector being used for insulation resistance testing was found to have a low resistance 35 to 55K megohms. A special teflon connector was fabricated which would give accurate readings. This change in connector masks changes in the insulation resistance measurements recorded on this unit.

This unit withstood pulsing to 30,000 volts. The unit was then subjected to a vacuum level of 1 x 10^{-6} mm Hg and pulsed with 20,000 volts. Following pulsing, the unit was returned to sea level condition and the electrical characteristics were recorded. This unit was then pulsed at vacuum and 13,000 volts rather than 23,000 volts. The unit fired. Spark gap breakdown on this unit varied between 500 and 2,000 volts.

Unit Serial No. 0211 had been rejected for high bridgewire resistance on Circuit C-D. The remaining characteristics were per specification. This unit produced an interbridge resistance of 1.214 on the AERMI prior to electrostatic pulsing. In the past, it was felt that only units which had been pulsed produced a reading greater than 1,000 on the AERMI. Further investigation into the history of this unit has shown that this unit had not been previously pulsed. Pulsing at the 9,000 volt level changed interbridge characteristics from 1.214 to 4.414. This unit withstood a pulse level of 30,000 volts at sea level. The unit subsequently fired when pulsed with 10,000 volts at a vacuum of 1 x 10^{-6} mm Hg. Spark gap breakdown varied between 1480 and 2080 volts.

Unit Serial No. 0013 had been also rejected for high bridgewire resistance (1.16 ohms) on Circuit C-D during final lot acceptance. Interbridge resistance changed from .450 to 4.444 after pulsing at 9,000 volts. This unit withstood 30,000 volts and subsequently fired when pulsed with 20,000 volts when at a vacuum of 1 x 10^{-6} mm Hg. Spark gap breakdown varied between 1,000 and 1,790 volts. Breakdown voltage at vacuum was 3150 volts.

Based upon data from the above units, an initial voltage level of 15,000 volts was chosen for units to be tested at vacuum, Serial Nos. 0184, 0180, 0118 and 0120, Lot No. AEK.

Unit Serial No. 0184 had been rejected as a helium leaker with an overall leak rate of 5.6 x 10^{-6} cc He. Bridgewire Circuit A-B had a low resistance of .923 ohms.

The unit was pulsed at 15,000 volts when at a vacuum of 1 x 10^{-6} mm Hg. The unit fired at this voltage level. Spark gap breakdown was 3,600 volts.

Unit Serial No. 0180 had been rejected prior to final lot acceptance as a helium leaker, subsequent testing determined that the electrical characteristics were per specification. Initial voltage level for the unit was reduced to 10,000 volts due to firing of 0184. Pulsing at 10,000 volts changed interbridge resistance reading on AERMI from .113 to 4.410. Interbridge capacitance changed from 3.0 pf to 6.8 pf, and pin to case capacitance changed from 9.8 pf to 11.0 pf. The unit was pulsed at 23,000 volts rather than 13,000 volts on the second pulse. The unit did not fire. The voltage level was reduced to 15,000 volts and pulsing continued. The unit fired when a voltage level of 21,000 volts was reached.

Unit Serial No. 0118 was rejected during final lot acceptance as a helium leaker, subsequent testing determined that the electrical characteristics were per specification. This unit was pulsed initially with 15,000 volts. The unit did not fire; however, interbridge resistance changed from .068 to 4.247, and interbridge capacitance

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changed from 3.6 pf to 4.5 pf, and pin to case capacitance changed from 7.7 pf to 10.5 pf. Initial insulation resistance was 35K megohms at 500 VDC and current leakage at 500 VAC was 6.0 micro amperes. After pulsing at 15,000, 18,000 and 21,000 volts, a short was created in the Dielectric Strength Mode and insulation resistance had changed from 35K megohms to 7 megohms. Pulsing at 24,000 volts developed a short in the insulation resistance mode. Subsequent pulsing to 30,000 volts did not fire the unit. This indicated that the breakdown path was not on the charge cup side of the header.

Dissection of the unit showed that pulsing had created a path between a header pin and the initiator body. This path was along the surface of the ceramic.

Unit Serial No. 0120 was rejected during final lot acceptance for an insulation resistance of less than one (1) megohm. As would be expected, this unit did not fire during pulsing; however, even with the short between the pins and case, interbridge resistance changed from .068 to .427 when pulsed with 15,000 volts and from .427 to 4.390 when pulsed with 18,000 volts.

Dissection of the unit also showed a shorting path between the potting compound and the ceramic face.

3.2 SPARK GAP BREAKDOWN

This investigation was instigated to determine the reproducibility of breakdown voltage with a constant gap width. Two electrodes with .030 radii were rigidly positioned with a .010 air gap. This test setup was made in the vacuum fixture so a vacuum could readily be applied without moving the setup. Three 9,000 and 25,000 volt discharges were conducted at both sea level and 1 x 10^{-6} mm Hg. Breakdown occurred between 3,000 and 4,500 volts at the 9,000 volt level and between 3,500 and 4,000 volts at the 25,000 volt level when at sea level.

After subjecting the test setup to a vacuum pressure of 1.1 x 10^{-6} mm Hg, three pulses of 9,000 volts were conducted. Of these, only one test indicated a breakdown voltage that being 6,300 compared to a previous high of 4,500 volts. Four pulses of 25,000 volts produced breakdown voltage between 11,000 and 13,200 volts.

Thus, the existing spark gap in the initiator, when subjected to a vacuum level of 1.1 x 10^{-6} mm Hg and a static pulse of 9,000 volts, will not reliably break down; and when breakdown does occur, it is at approximately twice the voltage observed at sea level. Breakdown voltage at a pulsing level of 25,000 volts occurs at approximately the same level as sea level conditions; however, under vacuum conditions, the breakdown levels are approximately three times as high.

3.3 INITIATION CHARGE PELLET INVESTIGATION

Testing of the units showed that changes in interbridge resistance were still prevalent. Investigations of the electrical characteristics of the initiation charge pellet have been conducted.

Initiation charge pellets were fabricated by pressing the initiation mix

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in standard pin headers and then cracking the ceramic charge cup and removing the pellet. Pellets were made using compaction pressures of 26,500 psi and 12,500. Insulating material was painted and cured on the circumference of the pellet in an effort to force applied voltage through the pellet.

One pellet of each density was placed between aluminum contacts and pulsed with 500 volts dc. Resistance, across the pellet, was measured before and after each pulse with the AIRME. Capacitance of the pellet was measured at one megacycle. Attempts were made to record dielectric strength of the pellet; however, current leakage was too great at high voltage. After each pulse testing on the AIRME showed a change in resistance characteristics; however, it was found that with the application of approximately 300°F for approximately 30 seconds, the resistance across the pellet returned to less than 1.00 on the AERMI. This pulsing, recording and heating cycle was repeated three times on the high density pellet and twice on the lower density pellet. In all cases resistance across the mix returned to the pre-pulse level. After three cycles of 500 volts dc, the voltage level on the dense pellet was increased in 500 volt increments until the pellet fired. This pellet fired when pulsed with 3,000 volts.

A second high density pellet was tested in the same manner except that a .005-thick mylar disk was placed between one side of the pellet and the aluminum contact. This pellet was pulsed starting at 500 volts dc and subsequently withstood 3,000 volts dc without either loosing resistance characteristics or firing.

Additional testing of the pellet was conducted by placing a dense pellet between two sharp probes and applying voltage in 5 volt increments. Each voltage level was maintained for a minimum of 30 seconds. The current leakage in micro amperes was recorded at the end of this period. After reaching the 60 volt level, testing was stopped. This level was limited by the available power supply. The pellet was tested to breakdown using ac voltage. Breakdown occurred at 160 VAC.

Following breakdown at 160 VAC, the pellet was again subjected to dc voltage levels, and leakage characteristics were again recorded. Resistance characteristics as expected were greatly reduced; however, it was found that by a slight movement of the pellet, the resistance characteristics returned. This test indicates that interbridge characteristic changes are with respect to a minute portion of the initiation charge only. Refer to data sheet and voltage vs current leakage plot.

In an effort to determine possible voltage surges at the charge side of the header, leads were welded to the pin faces and attached to an oscilloscope. A direct short between the pins and the case was created on the connector end of the header assembly, the unit was pulsed, and an oscilloscope picture taken of the surge voltage on the charge side of the header. Voltage levels of 500 and 550 volts dc were recorded.

This indicates that even though pictures taken of static breakdown voltage across the spark gap show voltage levels between 1,000 and 2,000 volts, the unit may be seeing surge voltages greatly in excess of the indicated voltage.

3.4 INTERNAL PULSE PROTECTION

As a result of the possible surge voltages, methods of internally insulating the circuits in an effort to stop breakdown of the initiation charge pellet were discussed.

Two methods were tried. The first method consisted of painting the initiation charge slurry with a resistive varnish, curing and then pressing initiation charge. These units are designated as A, B, C, D and E varnish on the data sheets.

The second method consisted of inserting a mylar insulating disk over the slurry and then pressing the initiation charge in place. Units were fabricated using three thicknesses of mylar; .002 designated on the data sheets as A_1, A_2, A_3, A_4 and A_5; .003 designated on the data sheets as B_1, B_2, B_3, B_4 and B_5; and .005 designated as C_1, C_2, C_3, C_4 and C_5.

One each of the above concepts was subjected to pulses starting at 9,000 VDC and subsequently were pulsed at 25,000 VDC. Concept A which utilized insulating varnish changed interbridge characteristics in the same manner as a standard unit.

The units with mylar disks between the slurry and the initiation charge pellet all withstood 25,000 volts with no significant changes in interbridge characteristics.

Four of the units with .002 mylar were placed in initiator bodies and subjected to a one amp, no fire test. Two units did not fire after 5 minutes. One unit fired approximately 2 minutes after application of current. The fourth unit was tested at 2 amperes in error and fired immediately.

It appears that the above method of interbridge protection warrants further investigation with respect to electrical insulation materials which have better heat transferring characteristics.

VI

APPENDIX

S/N CONCEPT	PULSE NO.	APPLIED VOLTAGE	BREAK-DOWN VOLTAGE VDC	INSUL. RES. AT 500 VDC (1)	BRIDGEWIRE RESISTANCE		DIELECTRIC STRENGTH AT 500 VAC MICRO AMPS	INTER-BRIDGE RES. CIR A-B to C-D	INTERBRIDGE CAP. AT ONE MEGACYCLE A-B to C-D	PIN TO CASE CAPACITANCE AT ONE MEGA-CYCLE	CONDITION	COMMENTS
					A-B	C-D						
CONCEPT "E" (continued)				30K	1.035	1.094	2	.069	2.7 pf	6.1 pf		
09	1	25,000		7.0K	1.030	1.088	36	.075	3.6 pf	7.5 pf	Sea Level	
	2	25,000		5.0K	1.029	1.088	98 @ 500 VAC	.080	3.7 pf	7.6 pf	Sea Level	
	3	25,000		27K	1.028	1.087	60	.075	3.9 pf	7.8 pf	Sea Level	
	4	25,000		12K	1.027	1.086	2	.070	3.8 pf	7.8 pf	Sea Level	
	5	25,000		7.0K	1.027	1.087	80	.083	3.7 pf	7.9 pf	Sea Level	

(1) Unless otherwise noted

S/N CONCEPT	PULSE NO.	APPLIED VOLTAGE	BREAK-DOWN VOLTAGE VDC	INSUL. RES. AT 500 VDC (1)	BRIDGEWIRE RESISTANCE		DIELECTRIC STRENGTH AT 500 VAC MICRO AMPS	INTER-BRIDGE RES. CIR A-B to C-D	INTERBRIDGE CAP. AT ONE MEGACYCLE A-B to C-D	PIN TO CASE CAPACITANCE AT ONE MEGA-CYCLE	CONDITION	COMMENTS
					A-B	C-D						
CONCEPT "E" (continued)				1.0K	1.035	1.034	100 @ 360 VAC	.070	2.9 pf	6.4 pf		
05	1	25,000		2.1K	1.029	1.030	100 @ 370 VAC	.082	3.4 pf	7.3 pf	Sea Level	
	2	25,000		2.8K	1.030	1.030	100 @ 395 VAC	.080	3.5 pf	7.4 pf	Sea Level	
	3	25,000		1.4K	1.029	1.030	100 @ 350 VAC	4.368	3.9 pf	7.6 pf	Sea Level	
	4	25,000		1.2K	1.027	1.028	100 @ 320 VAC	4.337	3.8 pf	7.7 pf	Sea Level	
	5	25,000		.95K	1.029	1.027	100 @ 370 VAC	4.366	3.7 pf	7.9 pf	Sea Level	
				15K	1.091	1.106	95	.069	2.7 pf	6.4 pf		
06	1	25,000		11K	1.090	1.104	56	.073	3.7 pf	7.7 pf	Sea Level	
	2	25,000		14K	1.089	1.102	70	.080	3.9 pf	7.8 pf	Sea Level	
	3	25,000		11K	1.083	1.103	100 @ 450 VAC	.077	3.9 pf	8.0 pf	Sea Level	
	4	25,000		3.8K	1.081	1.100	100 @ 450 VAC	.069	3.8 pf	7.9 pf	Sea Level	
	5	25,000		10K	1.075	1.102	65	4.270	3.6 pf	7.7 pf	Sea Level	
				2.1K	1.079	1.044	28	.069	2.9 pf	6.4 pf		
07	1	25,000		5.0K	1.076	1.032	100 @ 390 VAC	.930	3.6 pf	7.6 pf	Sea Level	
	2	25,000		2.6K	1.075	1.030	100 @ 380 VAC	1.250	3.7 pf	7.7 pf	Sea Level	
	3	25,000		2.8K	1.076	1.030	100 @ 410 VAC	4.366	4.0 pf	8.0 pf	Sea Level	
	4	25,000		550K	1.072	1.028	100 @ 405 VAC	4.339	3.9 pf	7.9 pf	Sea Level	
	5	25,000		5.0K	1.074	1.039	100 @ 450 VAC	.450	3.6 pf	7.8 pf	Sea Level	

(1) Unless otherwise noted

S/N CONCEPT	PULSE NO.	APPLIED VOLTAGE	BREAK-DOWN VOLTAGE VDC	INSUL. RES. AT 500 VDC (1)	BRIDGEWIRE RESISTANCE		DIELECTRIC STRENGTH AT 500 VAC MICRO AMPS	INTER-BRIDGE RES. CIR A-B to C-D	INTERBRIDGE CAP. AT ONE MEGACYCLE A-B to C-D	PIN TO CASE CAPACITANCE AT ONE MEGA-CYCLE	CONDITION	COMMENTS
					A-B	C-D						
CONCEPT "E" 01				.8 @ 250	1.103	1.114	100 @ 210 VAC	.068	2.5 pf	6.3 pf		
	1	25,000		.65 @ 250	1.103	1.114	50 @ 150 VAC	4.343	4.6 pf	7.9 pf	$1x10^{-6}$ mm Hg	
	2	25,000		.60 @ 250	1.098	1.109	100 @ 185 VAC	4.337	5.5 pf	8.4 pf	$1x10^{-6}$ mm Hg	
	3	25,000		.50 @ 250	1.100	1.111	100 @ 175 VAC	4.364	6.0 pf	8.5 pf	$1x10^{-6}$ mm Hg	
	4	25,000		.45 @ 250	1.101	1.112	100 @ 170 VAC	4.343	6.3 pf	8.7 pf	$1x10^{-6}$ mm Hg	
	5	25,000		.5 @ 250	1.105	1.119	100 @ 180 VAC	4.361	6.1 pf	8.7 pf	$1x10^{-6}$ mm Hg	
03				300K	.988	1.050	20	.070	2.6 pf	6.0 pf		
	1	25,000		12K	.987	1.048	45	.080	3.4 pf	7.3 pf	$1x10^{-6}$ mm Hg	
	2	25,000		13K	.982	1.050	30	4.337	7.6 pf	8.0 pf	$1x10^{-6}$ mm Hg	
	3	25,000		.85 @ 400	.986	1.047	100 @ 315 VAC	4.360	8.0 pf	8.2 pf	$1x10^{-6}$ mm Hg	
	4	25,000		.90 @ 450	.987	1.048	100 @ 320 VAC	4.345		8.3 pf	$1x10^{-6}$ mm Hg	
	5	25,000		.60 @ 300	.991	1.052	100 @ 250 VAC	4.362		8.4 pf	$1x10^{-6}$ mm Hg	
04				1.7K	1.018	1.053	100 @ 475 VAC	.087	2.6 pf	6.4 pf		
	1	25,000		6.0K	1.006	1.043	88 @ 400 VAC	4.340	9.2 pf	7.9 pf	$1x10^{-6}$ mm Hg	
	2	25,000		3.0K	1.002	1.040	96	4.334	8.8 pf	8.2 pf	$1x10^{-6}$ mm Hg	
	3	25,000		3.6K	1.004	1.040	100	4.359		8.2 pf	$1x10^{-6}$ mm Hg	
	4	25,000		10.0K	1.004	1.040	70	4.346		8.1 pf	$1x10^{-6}$ mm Hg	
	5	25,000		10.0K	1.008	1.044	100 @ 425 VAC	4.361		8.1 pf	$1x10^{-6}$ mm Hg	

(1) Unless otherwise noted

S/N CONCEPT	PULSE NO.	APPLIED VOLTAGE	BREAK-DOWN VOLTAGE VDC	INSUL. RES. AT 500 VDC	BRIDGEWIRE RESISTANCE A-B	BRIDGEWIRE RESISTANCE C-D	DIELECTRIC STRENGTH AT 500 VAC MICRO AMPS	INTER-BRIDGE RES. CTR A-B to C-D	INTERBRIDGE CAP. AT ONE MEGACYCLE A-B to C-D	PIN TO CASE CAPACITANCE AT ONE MEGA-CYCLE	CONDITION	COMMENTS
CONCEPT "D" (continued) 07				2.3K	1.129	1.081	1.0	.091	2.5 pf	6.6 pf		
	1	25,000	1700	290K	1.120	1.073	1.0	4.320	3.6 pf	8.7 pf	1×10^{-6}mm Hg	
	2	25,000	1600	27K	1.121	1.071	2.0	4.333	3.9 pf	8.8 pf	1×10^{-6}mm Hg	
	3	25,000	1750	48K	1.121	1.072	2.0	4.333	3.9 pf	8.9 pf	1×10^{-6}mm Hg	
	4	25,000	1100	90K	1.123	1.072	2.0	4.157	3.6 pf	7.5 pf	1×10^{-6}mm Hg	
	5	25,000	1325	450K	1.131	1.078	1.0	.480	3.9 pf	8.6 pf	1×10^{-6}mm Hg	
08				2K	1.078	1.033	>100 at 200 VAC	.095	2.9 pf	7.7 pf		
	1	25,000	800	Short	1.064	1.021	>100 at 10 VAC	.067	3.2 pf	8.7 pf	Sea Level	
	2	25,000	525	15K	1.064	1.022	10.0	3.800	3.7 pf	9.0 pf	Sea Level	
	3	25,000	1100	19K	1.062	1.021	>100 at 30 VAC	4.339	3.4 pf	8.9 pf	Sea Level	
	4	25,000		Short	1.086	1.020	>100 at 10 VAC	.200	6.0 pf		Sea Level	
	5	25,000		25K	1.068	1.022	>100 at 250 VAC	1.100	3.6 pf	9.2 pf	Sea Level	
03				60K	1.061	1.050	>100 at 400 VAC	..099	3.6 pf	8.4 pf		
	1	25,000	800	100K	1.051	1.042	Short	.078	4.0 pf	9.2 pf	Sea Level	> 100 Micro Amps at 10 VAC
	2	25,000	500	Short	1.048	1.042	Short	4.314	4.3 pf	9.1 pf	Sea Level	
	3	25,000	500	Short	1.048	1.042	Short	4.293	6.6 pf		Sea Level	
	4	25,000		Short	1.047	1.041	Short	.800	6.4 pf		Sea Level	
	5	25,000		Short	1.048	1.042	Short	.720	6.3 pf		Sea Level	

S/N CONCEPT	PULSE NO.	APPLIED VOLTAGE	BREAK-DOWN VOLTAGE VDC	INSUL. RES. AT 500 VDC	BRIDGEWIRE RESISTANCE A-B	BRIDGEWIRE RESISTANCE C-D	DIELECTRIC STRENGTH AT 500 VAC MICRO AMPS	INTER-BRIDGE RES. CIR A-B to C-D	INTERBRIDGE CAP. AT ONE MEGACYCLE A-B to C-D	PIN TO CASE CAPACITANCE AT ONE MEGA-CYCLE	CONDITION	COMMENTS
CONCEPT "D" 02				130K	1.089	1.141	1.0	.095	2.2 pf	5.4 pf		
	1	25,000	1525	19K	1.079	1.127	1.0	.300	2.5 pf	6.2 pf	$1x10^{-6}$ mm Hg	
	2	25,000	1650	22K	1.061	1.123	1.0	.750	2.6 pf	5.8 pf	$1x10^{-6}$ mm Hg	
	3	25,000	1600	2K	1.032	1.123	1.0	1.500	2.6 pf	6.1 pf	$1x10^{-6}$ mm Hg	
	4	25,000	1200	75K	1.032	1.122	1.0	.175	2.6 pf	5.9 pf	$1x10^{-6}$ mm Hg	
	5	25,000	1500	500K	1.039	1.129	1.0	.096	2.7 pf	5.9 pf	$1x10^{-6}$ mm Hg	
04				350K	1.092	1.073	1.0	.092	2.7 pf	6.0 pf		
	1	25,000	1550	65K	1.085	1.067	1.0	.077	3.4 pf	7.4 pf	$1x10^{-6}$ mm Hg	
	2	25,000	1775	140K	1.083	1.064	1.0	.150	3.5 pf	7.4 pf	$1x10^{-6}$ mm Hg	
	3	25,000	1425	37K	1.085	1.065	1.0	.400	3.5 pf	7.5 pf	$1x10^{-6}$ mm Hg	
	4	25,000		60K	1.086	1.066	1.0	4.157	5.7 pf	7.8 pf	$1x10^{-6}$ mm Hg	
	5	25,000	700	6K	1.092	1.073	1.5	4.163	5.7 pf	7.8 pf	$1x10^{-6}$ mm Hg	
05				1.2K	1.023	1.058	1.0	.090	2.7 pf	6.6 pf		
	1	25,000	1700	8K	1.018	1.052	2.0	.335	3.9 pf	8.8 pf	$1x10^{-6}$ mm Hg	
	2	25,000	1100	6K	1.015	1.049	2.0	4.335	4.0 pf	8.7 pf	$1x10^{-6}$ mm Hg	
	3	25,000	1000	3.8K	1.017	1.051	2.0	4.333	4.0 pf	8.8 pf	$1x10^{-6}$ mm Hg	
	4	25,000	1050	1K	1.016	1.052	2.0	2.100	3.6 pf	7.5 pf	$1x10^{-6}$ mm Hg	
	5	25,000	1050	800K	1.023	1.058	3.0	4.157	3.8 pf	8.8 pf	$1x10^{-6}$ mm Hg	

TABLE I (continued)

S/N CONCEPT	PULSE NO.	APPLIED VOLTAGE	BREAK-DOWN VOLTAGE VDC	INSUL. RES. AT 500 VDC	BRIDGEWIRE RESISTANCE A-B	BRIDGEWIRE RESISTANCE C-D	DIELECTRIC STRENGTH AT 500 VAC MICRO AMPS	INTER-BRIDGE RES. CIR A-B to C-D	INTERBRIDGE CAP. AT ONE MEGACYCLE A-B to C-D	PIN TO CASE CAPACITANCE AT ONE MEGA-CYCLE	CONDITION	COMMENTS
CONCEPT "C" (continued)				120K	1.089	1.158	1.0	.080	2.6 pf	7.9 pf		
012	1	25,000	1300								$1x10^{-6}$mm Hg	
				30K	1.066	1.154	2.0	4.156	No Reading	9.8 pf		
	2	25,000	1050								$1x10^{-6}$mm Hg	
				130K	1.066	1.152	4.0	3.966	4.4 pf	10.0 pf		
	3	25,000	1250								$1x10^{-6}$mm Hg	
				35K	1.062	1.151	12.0	.082	4.4 pf	9.8 pf		
	4	25,000	1050								$1x10^{-6}$mm Hg	
				300K	1.059	1.146	3.0	.080	4.4 pf	9.6 pf		
	5	25,000									$1x10^{-6}$mm Hg	
				400K	1.070	1.155	25.0	4.156	4.7 pf	10.1 pf		
				1000K	1.156	1.093	1.0	.080	2.3 pf	7.8 pf		
013	1	25,000									$1x10^{-6}$mm Hg	Unit Fired
				2.3K	1.108	1.189	1.0	.074	3.0 pf	10.0 pf		
014	1	25,000	2450								$1x10^{-6}$mm Hg	
				200K	1.110	1.120	2.0	3.980	4.7 pf	10.1 pf		
	2	25,000	1125								$1x10^{-6}$mm Hg	
				1.7K	1.098	1.110	2.0	4.169	4.6 pf	10.1 pf		
	3	25,000									$1x10^{-6}$mm Hg	
				2K	1.109	1.120	2.0	4.166	5.5 pf	10.5 pf		
	4	25,000	1200								$1x10^{-6}$mm Hg	
				4.6K	1.105	1.120	2.0	4.242	5.1 pf	10.6 pf		
	5	25,000	1250								$1x10^{-6}$mm Hg	
				7.0K	1.100	1.101	2.0	4.306	5.1 pf	10.4 pf		
				26K	1.132	1.208	2.0	.081	2.6 pf	10.1 pf		
016	1	25,000	2025								Sea Level	
				200K	1.103	1.149	2.0	4.311	4.4 pf	10.1 pf		
	2	25,000	1700								Sea Level	
				2K	1.096	1.144	2.0	4.165	4.7 pf	10.1 pf		
	3	25,000	1725								Sea Level	
				35K	1.085	1.151	2.5	4.176	4.7 pf	10.9 pf		
	4	25,000	1850								Sea Level	
				140K	1.082	1.148	2.5	4.097	4.7 pf	12.4 pf		
	5	25,000	1775								Sea Level	
				2K	1.084	1.149	2.5	4.137	5.2 pf	10.8 pf		

TABLE I (continued)

S/N CONCEPT	PULSE NO.	APPLIED VOLTAGE	BREAK-DOWN VOLTAGE VDC	INSUL. RES. AT 500 VDC	BRIDGEWIRE RESISTANCE A-B	BRIDGEWIRE RESISTANCE C-D	DIELECTRIC STRENGTH AT 500 VAC MICRO AMPS	INTER-BRIDGE RES. CIR A-B to C-D	INTERBRIDGE CAP. AT ONE MEGACYCLE A-B to C-D	PIN TO CASE CAPACITANCE AT ONE MEGA-CYCLE	CONDITION	COMMENTS
CONCEPT "C" 05	1	25,000	2820	4K	1.058	1.085	7.0	.058	2.4 pf	6.2 pf	$1x10^{-6}$ mm Hg	Unit Fired
06	1	25,000	2700	500K	1.060	1.096	4.0	.058	2.3 pf	6.2 pf	$1x10^{-6}$ mm Hg	Unit Fired
	1	25,000	3100	1000K	1.228	1.155	4.0	.060	2.4 pf	6.1 pf	$1x10^{-6}$ mm Hg	Unit Fired
**08	1	25,000	1900	4K	1.073	1.170	1.0	.072	2.3 pf	7.7 pf	$1x10^{-6}$ mm Hg	
	2	25,000	700	60K	1.070	1.164	70.0	4.154	5.1 pf	9.9 pf	$1x10^{-6}$ mm Hg	
	3	25,000	725	15K	1.067	1.158	>100 at 400 VAC	3.926	4.9 pf	10.0 pf	$1x10^{-6}$ mm Hg	
	4	25,000	650	3K	1.069	1.158	>100 at 400 VAC	4.290	4.5 pf	10.0 pf	$1x10^{-6}$ mm Hg	
	5	25,000	800	6K	1.065	1.159	>100 at 400 VAC	4.181	4.9 pf	10.1 pf	$1x10^{-6}$ mm Hg	
				4K	1.072	1.163	>100 at 400 VAC	4.152	4.5 pf	10.0 pf		
011	1	25,000	1350	28K	1.151	1.114	1.0	.072	2.4 pf	8.2 pf	$1x10^{-6}$ mm Hg	
	2	25,000	No Photo	200K	1.152	1.114	2.0	4.159	4.6 pf	10.1 pf	$1x10^{-6}$ mm Hg	
	3	25,000	1225	80K	1.142	1.109	2.0	3.977	5.1 pf	10.4 pf	$1x10^{-6}$ mm Hg	
	4	25,000	1250	7K	1.144	1.110	2.0	4.292	4.7 pf	10.3 pf	$1x10^{-6}$ mm Hg	
	5	25,000	1425	48K	1.138	1.107	2.0	4.172	5.1 pf	10.3 pf	$1x10^{-6}$ mm Hg	
				25K	1.147	1.111	2.0	4.152	5.4 pf	9.7 pf		

** Remaining units of Concept "C" had spark point on contact pins.
See Concept "C" illustration in Appendix.

TABLE I (continued)

S/N CONCEPT	PULSE NO.	APPLIED VOLTAGE	BREAK-DOWN VOLTAGE VDC	INSUL. RES. AT [illegible] VDC	BRIDGEWIRE RESISTANCE A-B	BRIDGEWIRE RESISTANCE C-D	DIELECTRIC STRENGTH AT 500 VAC MICRO AMPS	INTER-BRIDGE RES. CIR A-B to C-D	INTERBRIDGE CAP AT ONE MEGACYCLE A-B to C-D	PIN TO CASE CAPACITANCE AT ONE MEGA-CYCLE	CONDITION	COMMENTS
CONCEPT "C"												
01	1	25,000	----	500K	1.096	1.105	4.0	.060	2.3 pf	6.3 pf	Sea Level	Case cut away
	2	25,000	1300	50K	1.102	1.113	5.0	4.470	4.7 pf	8.6 pf		
	3	25,000	1400	1000K	1.084	1.098	2.5	4.510	6.2 pf	10.1 pf		
	4	25,000	1220	900K	1.092	1.106	2.5	4.519	7.8 pf	10.3 pf		
	5	25,000	1340		1.095	1.120	5.0	4.519	*8.4 pf	10.3 pf		*Poor Null
				500K	1.090	1.100	6.0	4.524	42.7 pf	10.4 pf	Sea Level	
02				30K	1.071	1.047	4.0	.059	2.3 pf	6.0 pf		
	1	25,000	----	7K	1.077	1.050	5.0	4.495	4.5 pf	8.8 pf	Sea Level	Connector end cut away unit fired
	2	25,000	2020								Sea Level	Connector end not cut away unit fired
03				4K	1.024	.991	3.5	.057	2.3 pf	6.1 pf		
	1	25,000	----								Sea Level	
Control Sample 04				300K	1.064	1.086	4.0	.061	2.5 pf	6.3 pf		
	1	------	----	350K	1.073	1.090	2.0	.052	2.8 pf	7.4 pf	Sea Level	
	2	------	----	2000K	1.064	1.079	2.0	.050	2.8 pf	7.6 pf		Re-adjusted AERMI
	3	------	----	500K	1.066	1.086	2.0	0	2.9 pf	7.7 pf		
	4	------	----	400K	1.076	1.095	1.8	0	3.0 pf	7.6 pf	Sea Level	
	5	------	----	1000K	1.071	1.086	2.1	0	3.0 pf	7.8 pf		

TABLE I (continued)

S/N CONCEPT	PULSE NO.	APPLIED VOLTAGE	BREAK-DOWN VOLTAGE VDC	INSUL. RES. AT 500 VDC	BRIDGEWIRE RESISTANCE A-B	BRIDGEWIRE RESISTANCE C-D	DIELECTRIC STRENGTH AT 500 VAC MICRO AMPS	INTER-BRIDGE RES. CIR A-B to C-D	INTERBRIDGE CAP. MICROCKT A-B to C-D	PIN TO CASE CAPACITANCE AT END CYCLE	CONDITION	COMMENTS
CONCEPT B												
				500K	1.085	1.050	3.0	.066	4.0 pf	6.2 pf		
02	1	25,000	2020								1 x 10^{-6} mm Hg	
				1000K	1.056	1.121	3.0	.065	4.0 pf	6.5 pf		
03	1	25,000	2000		1.049	1.083	5.0	4.535	4.6 pf	9.7 pf	1 x 10^{-6} mm Hg	
	2	25,000	4500	25K	1.051	1.081	5.0	4.471	----	9.7 pf		
	3	25,000	800	500K	1.048	1.087	4.5	4.460	----	9.7 pf		
	4	25,000	4500	180K	1.043	1.077	4.5	4.482	----	10.2 pf		
	5	25,000	4400		1.048	1.081	5.0	4.423	----	10.2 pf	1 x 10^{-6} mm Hg	Interbridge resistance 248.1 ohms measured with a cubic digital ohmmeter.
				900K	1.085	1.103	3.0	.064	4.3 pf	6.9 pf		
04	1	25,000	1100	400K	1.083	1.125	4.0	4.531	4.3 pf	8.9 pf	1 x 10^{-6} mm Hg	
	2	25,000	1100	30K	1.091	1.134	4.5	4.466	4.7 pf	9.1 pf		
	3	25,000	1200	60K	1.087	1.114	4.0	4.464	4.4 pf	10.7 pf		
	4	25,000	1200	1000K	1.082	1.101	4.0	4.482	4.4 pf	9.1 pf		
	5	25,000	1100	60K	1.084	1.102	4.5	4.424	4.3 pf	9.0 pf	1 x 10^{-6} mm Hg	
				Short	1.117	1.146	Short	.057	2.1 pf	5.3 pf		
01	1	NA	NA	Short	1.116	1.123	Short	.060	2.6 pf	5.3 pf	Sea Level	
	2	NA	NA	Short	1.121	1.121	Short	.070	3.5 pf	5.3 pf	Sea Level	
	3	NA	NA	Short	1.126	1.130	Short	.076	3.5 pf	---		
	4	NA	NA	Short	1.114	1.123	Short	.102	4.0 pf	---		
	5	NA	NA	Short	1.128	1.122	Short	.129	3.3 pf	---		
	6	NA	NA	Short	1.127	1.123	Short	.094	2.3 pf	5.4 pf		
	7	NA	NA	Short	1.122	1.117	Short	.083	2.0 pf	5.5 pf	Sea Level	

TABLE I (continued)

							MICRO AMPS					
CONCEPT "B"												
				1000K	1.103	.948	2.5	.072	2.6 pf	1.4 pf		
05	1	25,000	1430	80K	1.108	.999	4.0	.062 (7-28) 4.108 (7-27)	4.1 pf (7-28)	7.5 pf	Sea Level	Interbridge capacitance reading in error.
	2	25,000	1100		1.110	.992	4.0	.630	5.5 pf	7.5 pf		
	3	25,000	1070	∞	1.115	.991	4.0	.320	3.6 pf	7.8 pf		
	4	25,000	--	∞	1.106	.994	4.0	.090	---	7.9 pf		
	5	25,000	1160	400K	1.104	.990	4.0	.149	3.3 pf	7.8 pf	Sea Level	
				700K	1.089	1.060	3.0	.068	2.5 pf	1.4 pf		
06	1	25,000	1090	150K	1.147	1.066	3.5	.118 (7-28) .890 (7-27)	4.1 pf (7-28)	8.1 pf	Sea Level	Interbridge capacitance reading in error.
	2	25,000	1170	150K	1.117	1.068	4.0	.180	5.0 pf	7.5 pf		
	3	25,000	1150	70K	1.120	1.071	4.0	4.406	3.7 pf	8.0 pf		
	4	25,000	1510	20K	1.118	1.086	4.0	.064	3.4 pf	8.3 pf		
	5	25,000	1170	12K	1.119	1.080	4.0	.060	3.2 pf	8.2 pf	Sea Level	
				800K	1.174	1.006	3.0	.062	2.8 pf	1.1 pf		
07	1	25,000	1900	∞	1.298	1.062	3.5	.160 (7-28) 4.233 (7-27)	5.1 pf (7-28)	8.7 pf	Sea Level	Interbridge capacitance reading in error.
	2	25,000	1340	7000K	1.136	1.062	4.0	4.391	6.5 pf	8.5 pf		
	3	25,000	1500	10000K	1.139	1.071	4.5	4.401	4.1 pf	8.6 pf		
	4	25,000	2030	10000K	1.137	1.060	4.0	.0[illegible]	4.4 pf	8.8 pf		
	5	25,000	2070	5000K	1.137	1.062	4.5	470	4.1 pf	8.6 pf	Sea Level	

TABLE I (continued)

[illegible]	[illegible] NO.	[illegible]	[illegible] VOLTAGE VDC	INSUL. RES. [illegible] VDC	[illegible] A-B	[illegible] C-D	DIELECTRIC [illegible] VAC MICRO AMPS	INTER-BRIDGE RES. [illegible] A-B to C-D	INTERBRIDGE [illegible] A-B to C-D	[illegible]	[illegible]	[illegible]
0118 Lot AEK				35K	1.078	1.052	6.0	.068	3.6 pf	7.7 pf	1×10^{-6} mm Hg	
	1	15,000	3000	50	1.057	1.057	4.0	4.247	4.5 pf	10.5 pf		
	2	18,000	1600	55	1.062	1.055	9.C	4.396	4.8 pf	10.9 pf		
	3	21,000	1450	7.0	1.062	1.057	Short	4.395	4.5 pf	10.8 pf		
	4	24,000	200	Short	1.031	1.044	Short	4.379	4.7 pf	10.6 pf		
	5	27,000	300	Short	1.034	1.056	Short	4.362	5.0 pf	10.6 pf		
	6	30,000	270	Short	1.029	1.054	Short	4.371	5.2 pf	10.9 pf	1×10^{-6} mm Hg	Interbridge resistance 103.9K ohms. shorted pins to case resistance 76.9K ohms measured with a cubic digital ohmmeter.
0120 Lot AEK				Short	1.020	.931	Short	.068	7.4 pf	9.1 pf	1×10^{-6} mm Hg	
	1	15,000	-----	Short	1.020	.935	Short	.427	4.4 pf	10.7 pf		
	2	18,000	700	Short	1.023	.936	Short	4.390	6.8 pf	11.4 pf		
	3	21,000	-----	Short	1.026	.938	Short	4.394	4.1 pf	11.6 pf		
	4	24,000	-----	Short	1.022	.935	Short	4.385	8.7 pf	12.1 pf		
	5	27,000	-----	Short	1.024	.934	Short	4.345	7.7 pf	11.7 pf		
	6	30,000	50	Short	1.070	.923	Short	4.373	6.1 pf	11.6 pf	1×10^{-6} mm Hg	Interbridge resistance 153.9K ohms. shorted pins to case 3.979 megohms measured with a cubic digital ohmmeter.

TABLE I (continued)

[illegible]	PULSE NO.	APPLIED VOLTAGE	BREAK-DOWN VOLTAGE VDC	INSUL. RES. AT 500 VDC	BRIDGEWIRE RESISTANCE A-B	C-D	DIELECTRIC STRENGTH AT 500 VAC MICRO AMPS	INTER-BRIDGE RES. CIR A-B to C-D	INTERBRIDGE CAP. AT ONE MEGACYCLE A-B to C-D	[illegible] AT ONE MEGACYCLE	[illegible]	[illegible]
0013 Lot AEK	1	9,000	1790	35K	1.08	1.15	3.0	.450	3.0 pf	9.5 pf	Sea Level	
	2	12,000	1700	35K	1.084	1.155	3.0	4.444	4.1 pf	9.7 pf		
	3	15,000	1700	26K	1.080	1.136	4.0	4.435	4.0 pf	9.7 pf		
	4	18,000	1000	43K	1.078	1.114	5.0	4.228	4.1 pf	9.9 pf		
	5	21,000	1780	35K	1.080	1.116	6.0	4.238	4.4 pf	9.9 pf		
	6	24,000	1700	200K	1.078	1.114	6.0	4.261	4.7 pf	10.0 pf		
	7	27,000	1650	180K	1.072	1.114	5.0	4.358	4.6 pf	10.0 pf		
	8	30,000	1670	50K	1.076	1.116	5.0	4.406	4.5 pf	10.0 pf	Sea Level	
	9	20,000	3150	65K	1.075	1.116	5.5	4.400	4.7 pf	10.0 pf	1×10^{-6} mm Hg	Unit fired
0184 Lot AEK	1	15,000	3600	700K	.923	.958	6.0	.067	3.0 pf	9.1 pf	1×10^{-6} mm Hg	Unit fired
0180 Lot AEK	1	10,000	2600	35K	1.06	1.09	3.0	.113	3.0 pf	9.8 pf	1×10^{-6} mm Hg	
	2	23,000	2900	75K	1.058	1.095	6.0	4.410	6.8 pf	11.0 pf		
	3	15,000	5100	50K	1.034	1.095	6.C	4.413	6.8 pf	11.2 pf		
	4	18 000	-----	2000K	1.026	1.092	7.0	4.247	11.7 pf	11.1 pf		
	5	21,000	370	2000K	1.025	1.094	7.5	4.392	8.2 pf	11 0 pf	1×10^{-6} mm Hg	Unit fired

TABLE I

S/N CONCEPT	PULSE NO.	APPLIED VOLTAGE	BREAK-DOWN VOLTAGE VDC	INSUL. RES. AT 500 VDC	BRIDGEWIRE RESISTANCE A-B	BRIDGEWIRE RESISTANCE C-D	DIELECTRIC STRENGTH AT 500 VAC MICRO AMPS	INTER-BRIDGE RES. CIR A-B to C-D	INTERBRIDGE CAP. AT ONE MEGACYCLE A-B to C-D	PIN TO CASE CAPACITANCE AT ONE MEGACYCLE	CONDITION	COMMENTS
0006 Lot AEK Std. Unit	1	9,000	620	35K	1.16	1.11	3.0	.110	3.4 pf	11.0 pf	Sea Level	
	2	12,000	1760	35K	1.160	1.108	3.0	4.446	6.2 pf	11.7 pf		
	3	15,000	1430	26K	1.158	1.107	4.0	4.440	6.6 pf	11.7 pf		
	4	18,000	1270	55K	1.152	1.101	5.0	4.238	6.0 pf	11.8 pf		
	5	21,000	1480	*40K	1.154	1.103	*6.0	4.254	6.3 pf	11.8 pf		
	6	24,000	2000	∞	1.156	1.101	7.0	4.253	6.8 pf	11.9 pf		
	7	27,000	1770	45K	1.148	1.100	6.0	4.371	6.6 pf	11.9 pf		
	8	30,000	1950	52K	1.150	1.101	6.0	4.410	6.4 pf	11.9 pf	Sea Level	
	9	20,000	500	80K	1.149	1.101	6.0	4.404	6.3 pf	12.0 pf	1 x 10^{-6} mm Hg	
	10	13,000	660	5K	1.154	1.104	6.0	4.414	6.0 pf	10.2 pf	1 x 10^{-6} mm Hg	Pulsed at 13,000 volts by mistake - should have been 23,000 unit fired.
0211 Lot AEK	1	9,000	1950	35K	1.080	1.200	3.0	1.214	3.1 pf	10.5 pf	Sea Level	Unit had not previously been pulsed
	2	12,000	2080	38K	1.074	1.183	3.0	4.414	4.1 pf	10.6 pf		
	3	15,000	2050	25K	1.073	1.161	4.C	4.428	4.3 pf	10.7 pf		
	4	18,000	1970	58K	1.067	1.153	5.0	4.238	4.5 pf	10.9 pf		
	5	21,000	1980	40K	1.070	1.155	6.0	4.238	4.6 pf	10.9 pf		
	6	24,000	1920	∞	1.068	1.153	7.0	4.212	5.5 pf	10.9 pf		
	7	27,000	1790	14K	1.070	1.140	5.5	4.363	4.9 pf	10.8 pf		
	8	30,000	1480	28K	1.071	1.143	5.0	4.387	4.7 pf	10.9 pf	Sea Level	
	9	10,000	2700	38K	1.070	1.141	5.5	4.403	4.6 pf	10.9 pf	Sea Level 1 x 10^{-6} mm Hg	

*Following this Test an improved shorting connector having higher insulation resistance and dielectric strength properties will be used.

TABLE I (continued)

S/N CONCEPT	PULSE NO.	APPLIED VOLTAGE	BREAK-DOWN VOLTAGE VDC	INSUL. RES. AT 500 VDC	BRIDGEWIRE RESISTANCE A-B	BRIDGEWIRE RESISTANCE C-D	DIELECTRIC STRENGTH AT 500 VAC MICRO AMPS	INTER-BRIDGE RES. CIR A-B to C-D	INTERBRIDGE CAP. AT ONE MEGACYCLE A-B to C-D	PIN TO CASE CAPACITANCE AT ONE MEGA-CYCLE	CONDITION	COMMENTS
CONCEPT "G"												
01	1	25,000	3100	100K	1.10	1.08	----------	NA	NA	17.4 pf	1×10^{-3} mm Hg	Unit fired
								NA	NA	9.7 pf		
02	1	25,000	1400	700K	1.13	1.08	----------	NA	NA	16.6 pf	1×10^{-6} mm Hg	Unit fired
03	1	25,000	1800	700K	1.10	1.07	-----------	NA	NA	17.2 pf	1×10^{-6} mm Hg	Unit fired
CONCEPT "H"												
02	1	25,000	1950	1500K	1.092	1.041	5.5	NA	NA	11.7 pf	Sea Level	Unit fired circuit B-C Resistance 1.12 ohms.
03	1	25,000	1950	3000K	1.023	1.029	5.0	NA	NA	11.6 pf	Sea Level	Unit fired circuit B-C Resistance 1.13 ohms.
04	1	9,000	1500	1000K	1.106	1.114	5.5	NA	NA	11.8 pf	Sea Level	Unit fired circuit B-C Resistance 1.20 ohms.

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SPACE ORDNANCE SYSTEMS, INC.

TABLE II

S/N	PULSE MODE	PRE-PULSE CAPACITANCE IN PULSE MODE	PRE-PULSE AIRME IN PULSE MODE	PULSE VOLTAGE	VARISTOR	POST PULSE CAPACITANCE IN PULSE MODE	POST-PULSE AIRME IN PULSE MODE	REMARKS
12006	PIN B TO CASE	8.2 PF	.066	10 KV	NO	—	—	UNIT FIRED
12045		8.3PF	.072	10 KV	NO	—	—	UNIT FIRED
12036		8.2PF 16.4PF W/ VARISTOR	.071	12 KV	YES	15.2PF	.057	
		15.2PF	.057	14 KV		15.4 PF	.056	
		15.4PF	.056	16KV		14.3PF	.068	
		14.3PF	.068	18KV		15.0PF	.077	
		15.0PF	.077	20KV		16.1 PF	.068	
		16.1PF	.068	22KV		16.2PF	.068	
		16.2PF	.068	24 KV		16.0PF	.069	
		16.0PF	.069	26KV		16.1PF	.068	
		16.1PF	.068	28KV		16.1PF	.067	
		16.1PF	.067	30KV		—	—	NO FIRE TEST STOPPED.
12044		8.4PF 17.6PF W/ VARISTOR	.073	12KV		16.5PF	.061	
		16.5PF	.061	14 KV		16.4PF	.070	
	PIN B TO CASE	16.4 PF	.070	16KV	YES	16.0PF	.068	

SPACE ORDNANCE SYSTEMS, INC.

TABLE II

S/N.	PULSE MODE	PRE-PULSE CAPACITANCE IN PULSE MODE	PRE-PULSE AIRME IN PULSE MODE	PULSE VOLTAGE	VARISTOR	POST PULSE CAPACITANCE IN PULSE MODE	POST-PULSE AIRME IN PULSE MODE	REMARKS
12044	PIN B TO CASE	16.0 PF	.068	18 KV	YES	16.0 PF	.068	
	PIN B TO CASE	16.0 PF	.068	20 KV	YES	16.1 PF	.070	
	PIN B TO CASE	16.1 PF	.070	22 KV	YES	—	—	UNIT FIRED
12050	PIN A TO PIN C	6.1 PF	.066	10 KV	NO	SHORT	4.389	
		SHORT	4.389	12 KV	NO	—	—	UNIT FIRED
12047		6.1 PF	.070	10 KV	NO	—	—	UNIT FIRED
12018		8.4 PF CUBIC 173.0 Ω	.066	12 KV	YES	CUBIC 170.9 Ω	4.388	
		CUBIC 170.9 Ω	4.388	14 KV	YES	CUBIC 136.4	4.931	
		CUBIC 136.4 Ω	4.931	16 KV	YES	—	—	UNIT FIRED
12041		7.7 PF CUBIC 147.2 Ω 7.8 PF W/VARISTOR	.066	12 KV	YES	CUBIC 41.93 Ω	4.611	
		CUBIC 41.93 Ω	4.611	16 KV	YES	CUBIC 42.65 Ω	4.413	
	PIN A TO PIN C	CUBIC 42.65 Ω	4.413	18 KV	YES	CUBIC 42.11 Ω	4.600	

SPACE ORDNANCE SYSTEMS, INC.

TABLE II

S/N.	PULSE MODE	PRE-PULSE CAPACITANCE IN PULSE MODE	PRE-PULSE AIRME IN PULSE MODE	[illegible]	[illegible]	POST PULSE CAPACITANCE IN PULSE MODE	POST-PULSE AIRME IN PULSE MODE	REMARKS
12041	PIN A TO CASE	CUBIC 41.11 Ω	4.600	[illegible] KV	YES	CUBIC 43.45 Ω	4.445	
	PIN A TO CASE	CUBIC 43.45 Ω	4.445	22 KV	YES	CUBIC 56.05 Ω	4.415	
	PIN A TO CASE	CUBIC 56.05 Ω	4.415	24 KV	YES	—	—	UNIT FIRED

GENERAL TESTING

STANDARD UNIT TEST DATA

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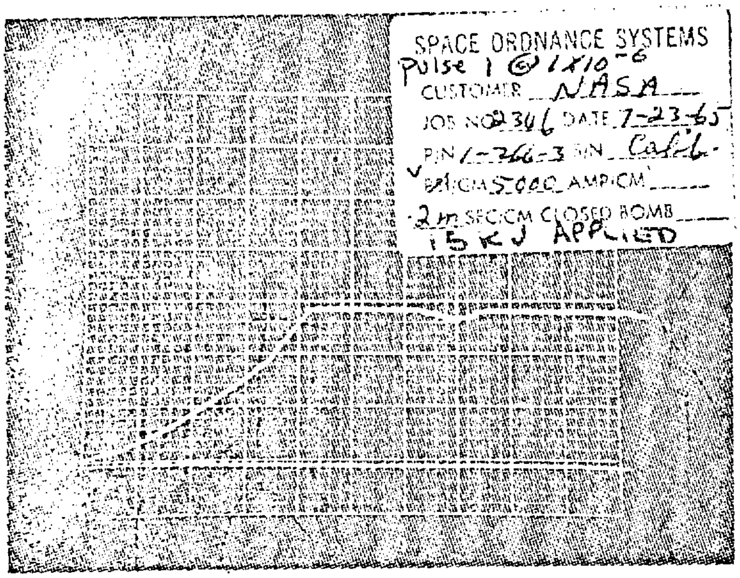

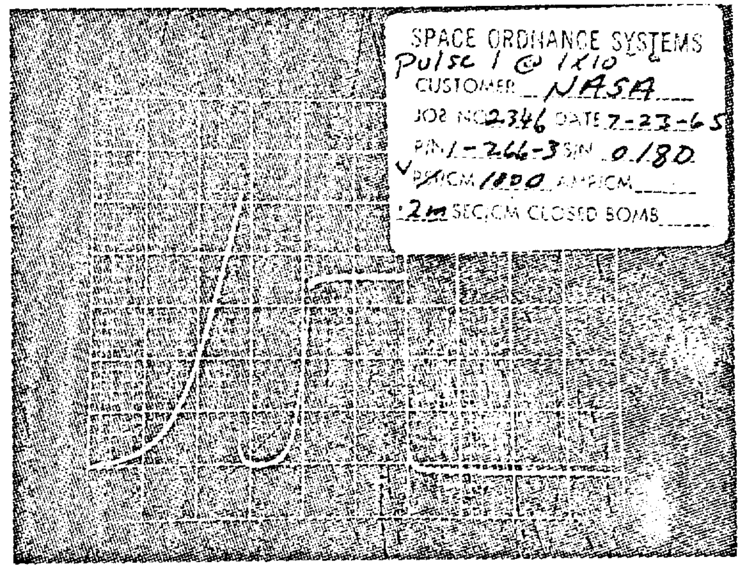

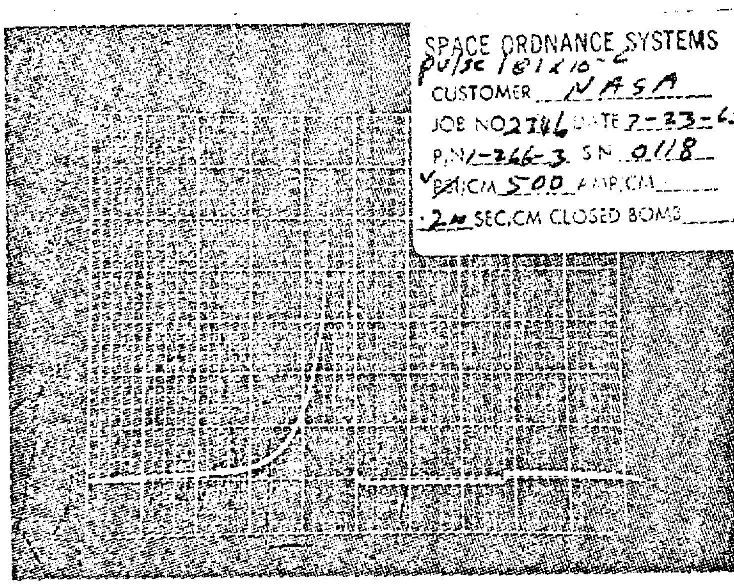

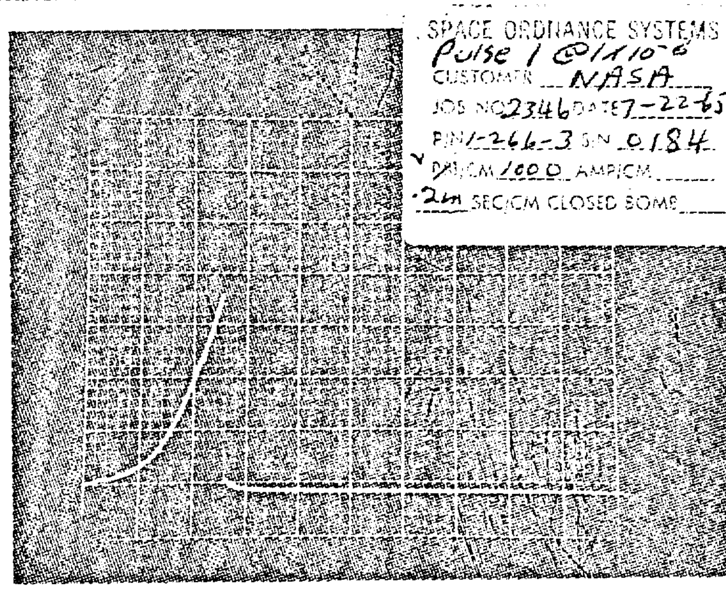

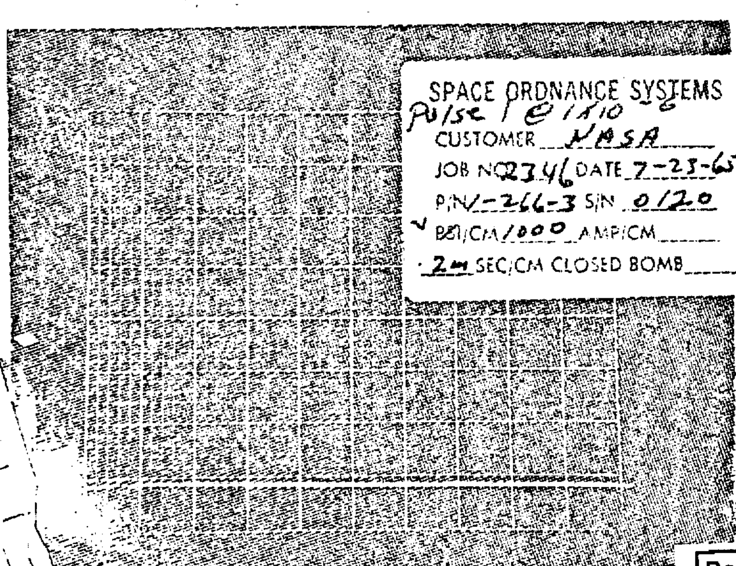

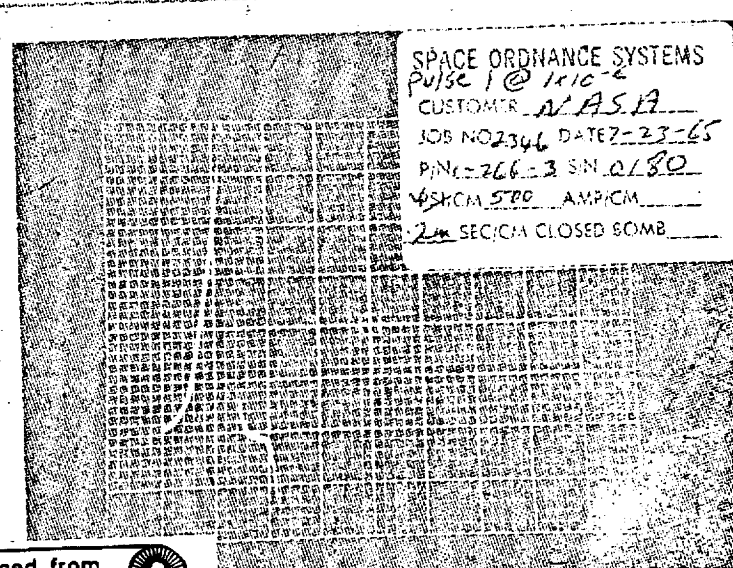

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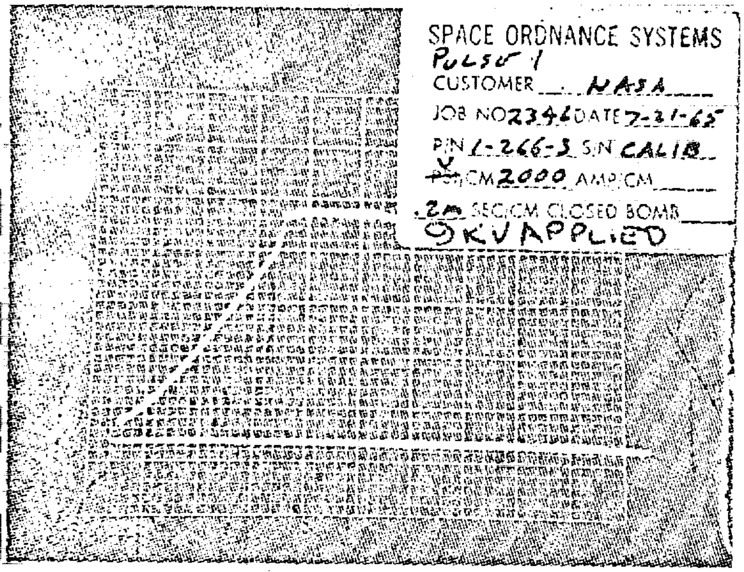

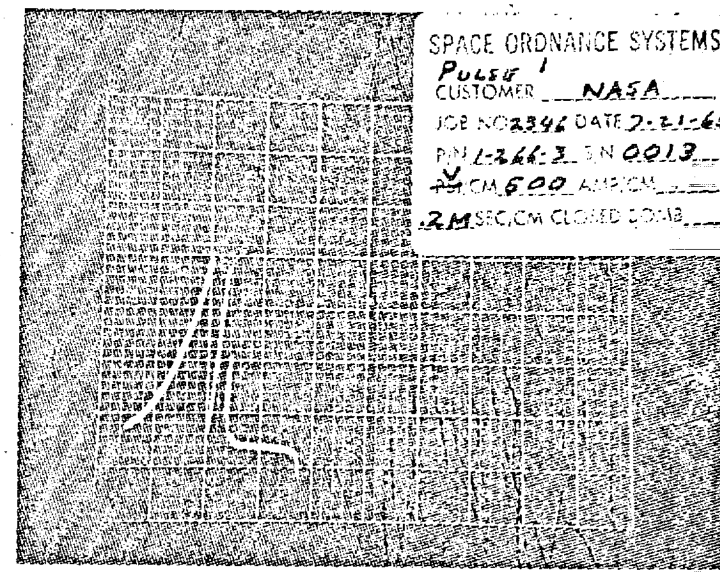

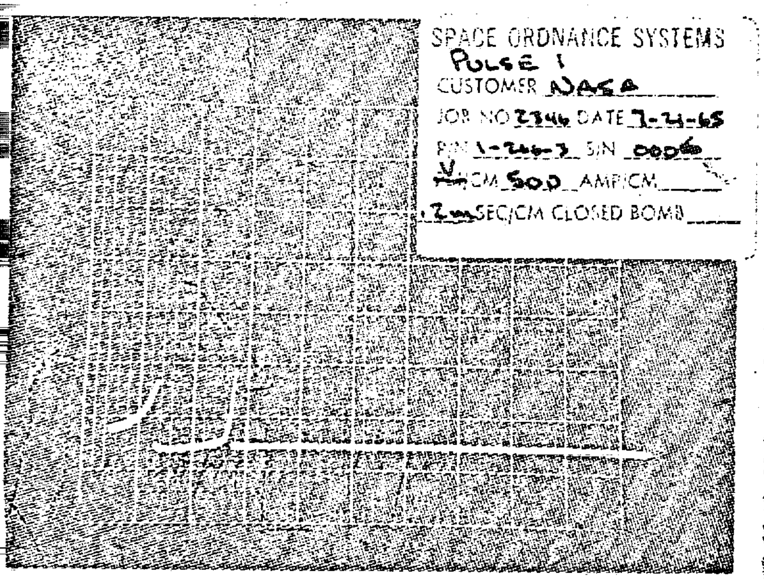

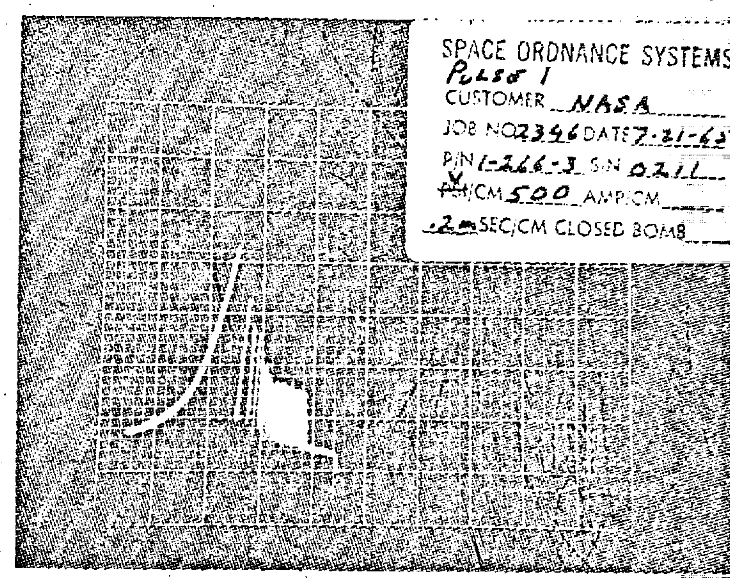

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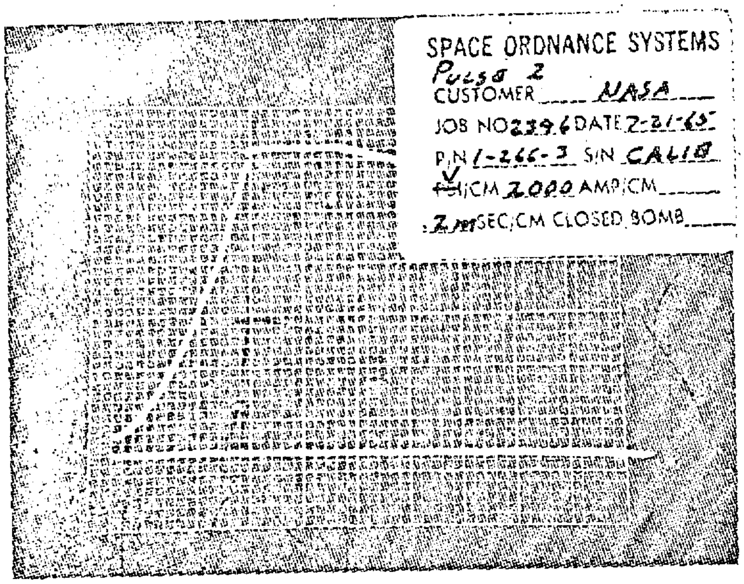

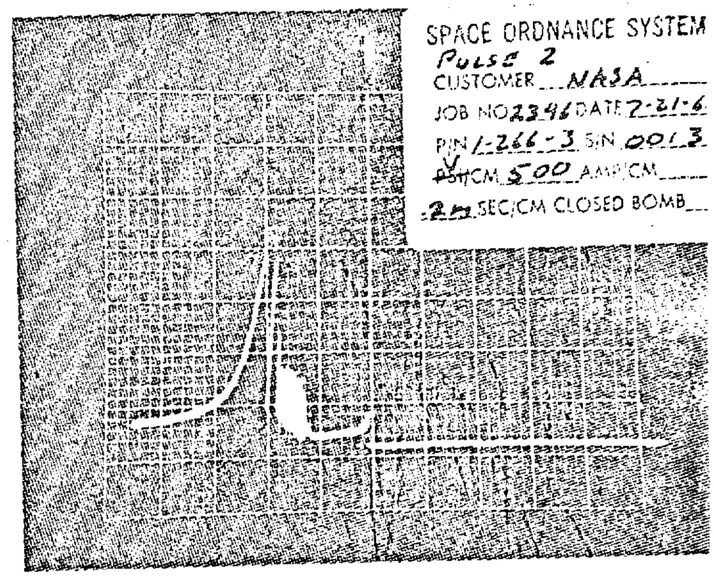

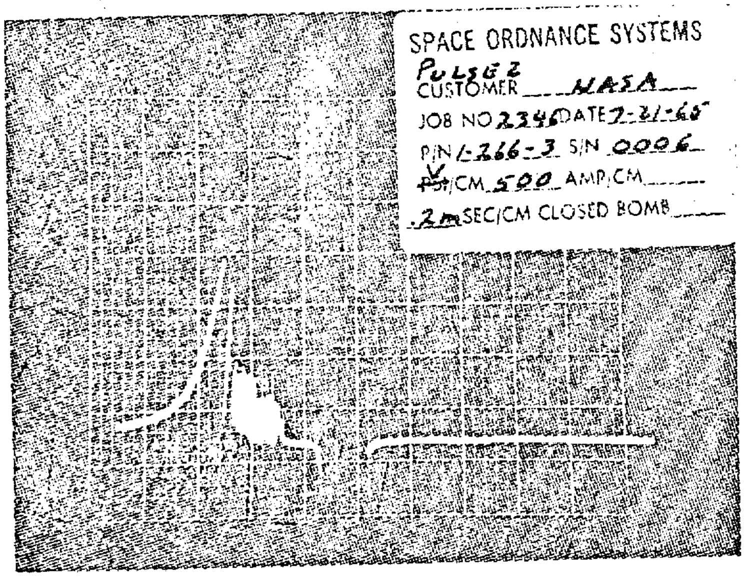

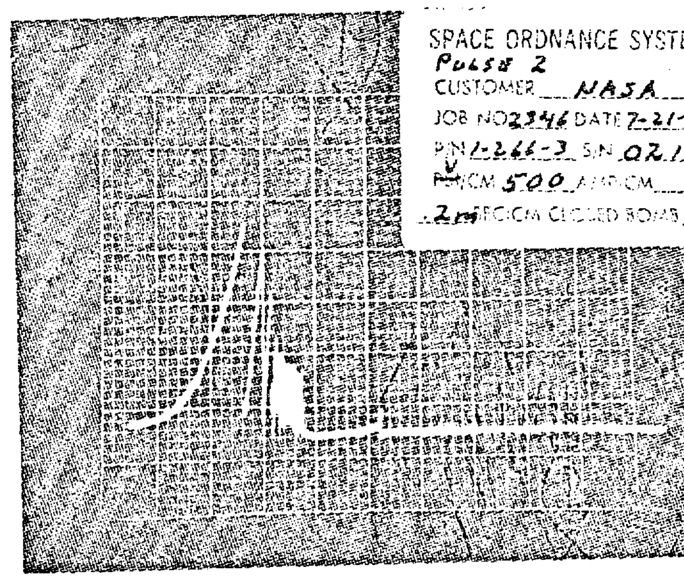

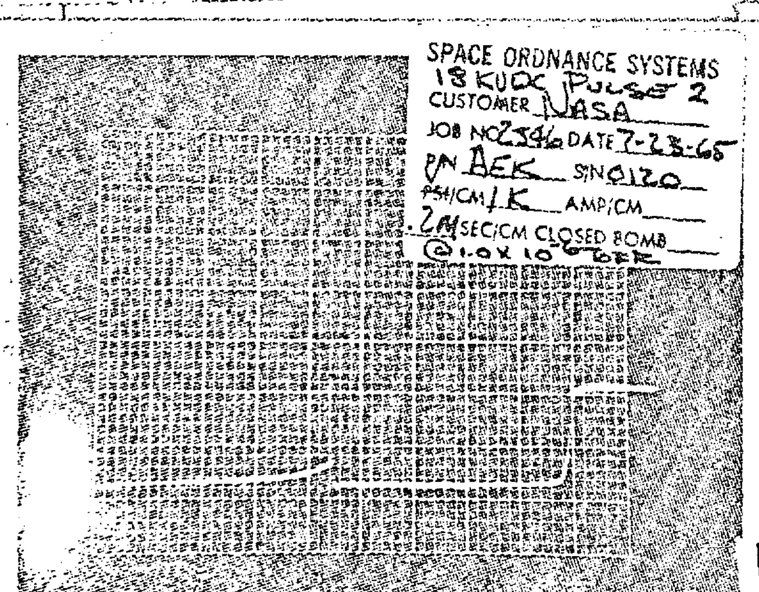

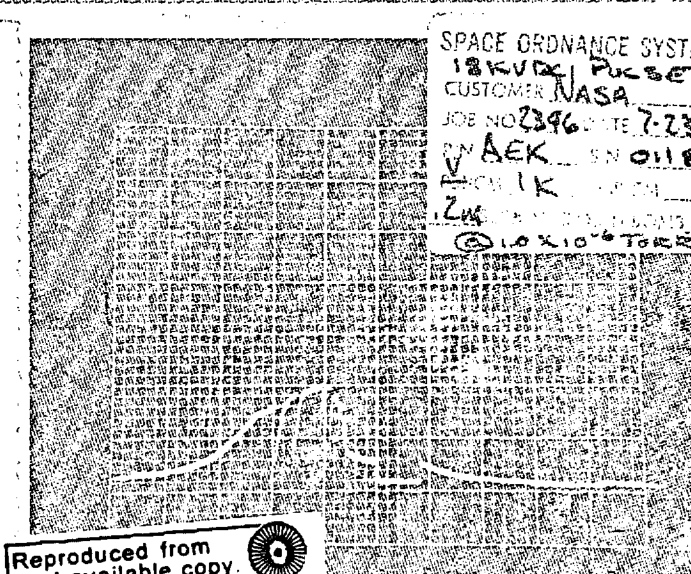

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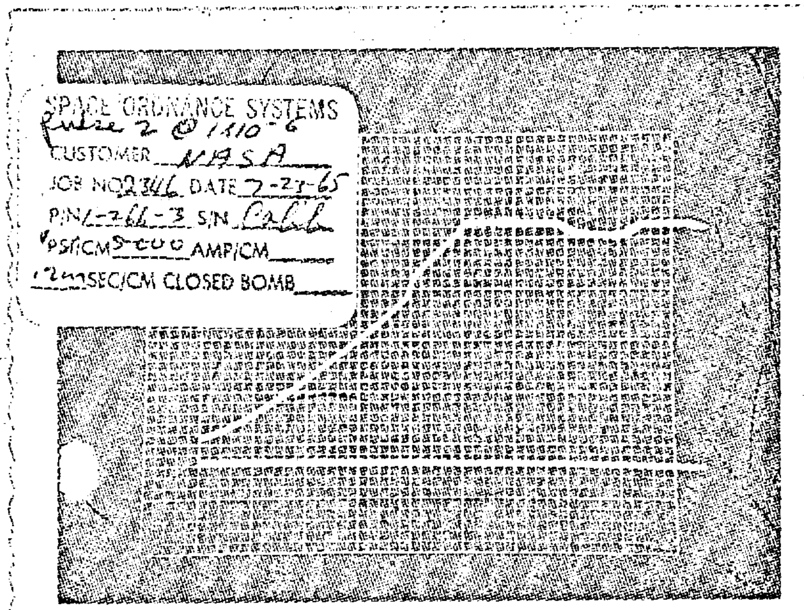

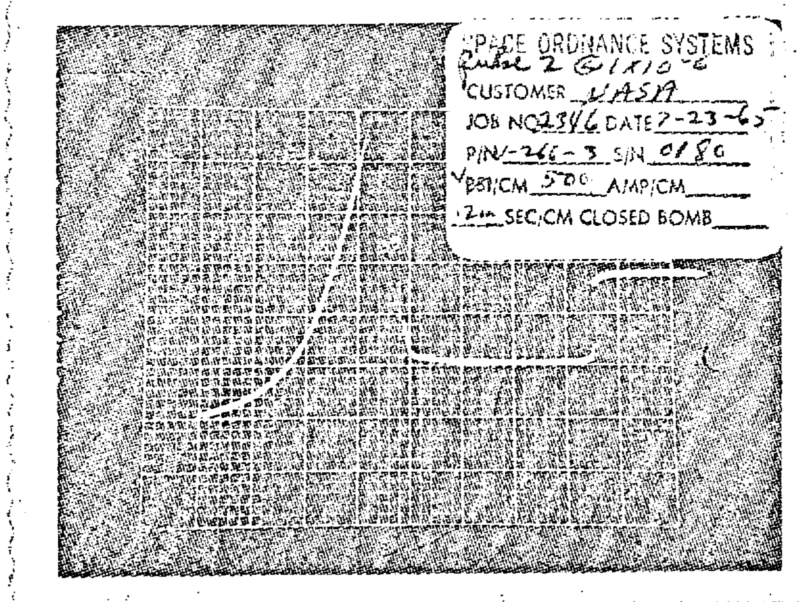

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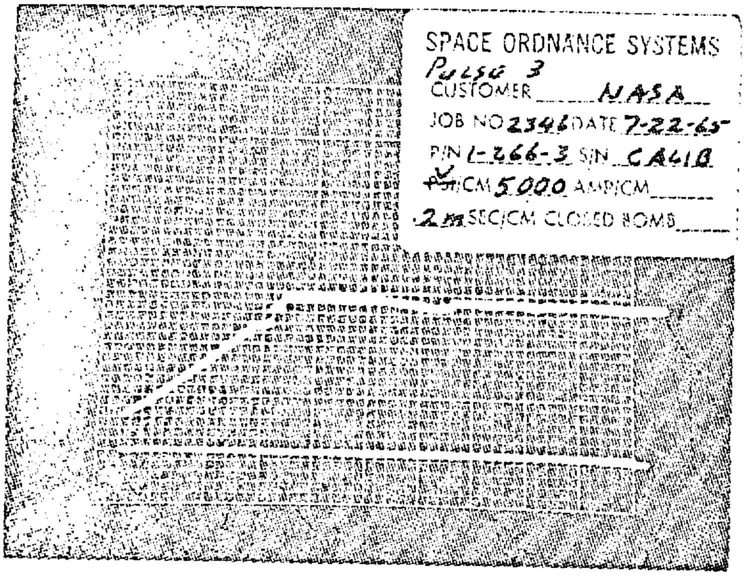

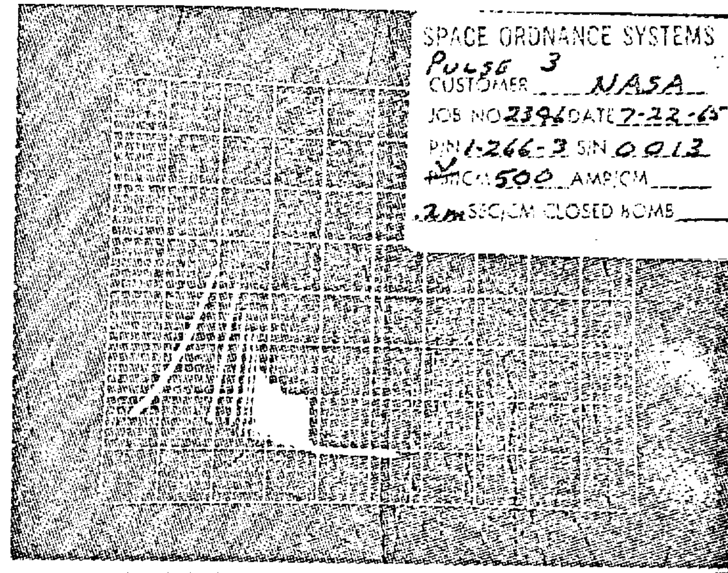

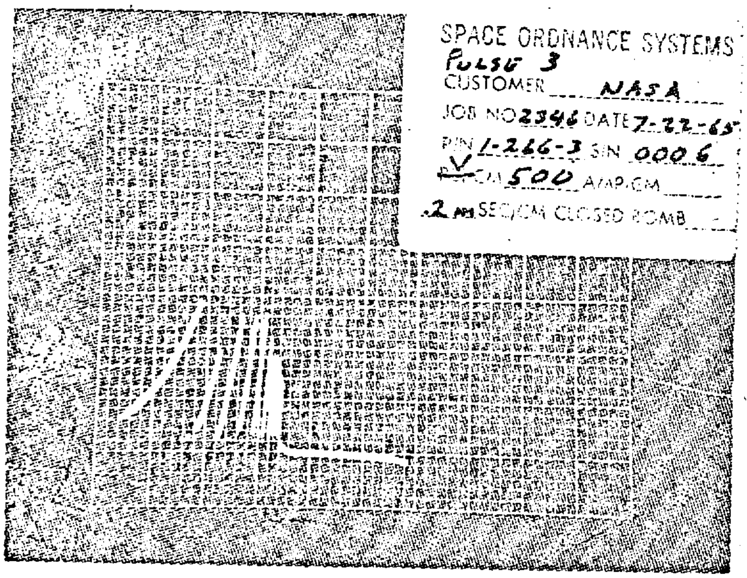

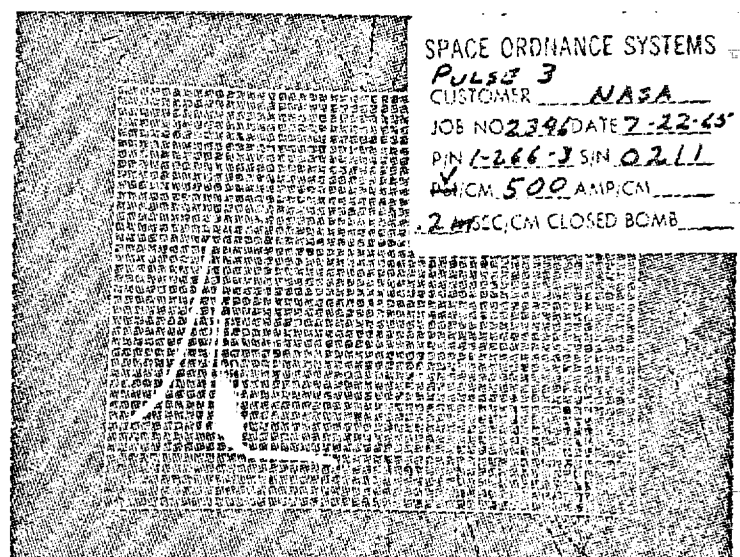

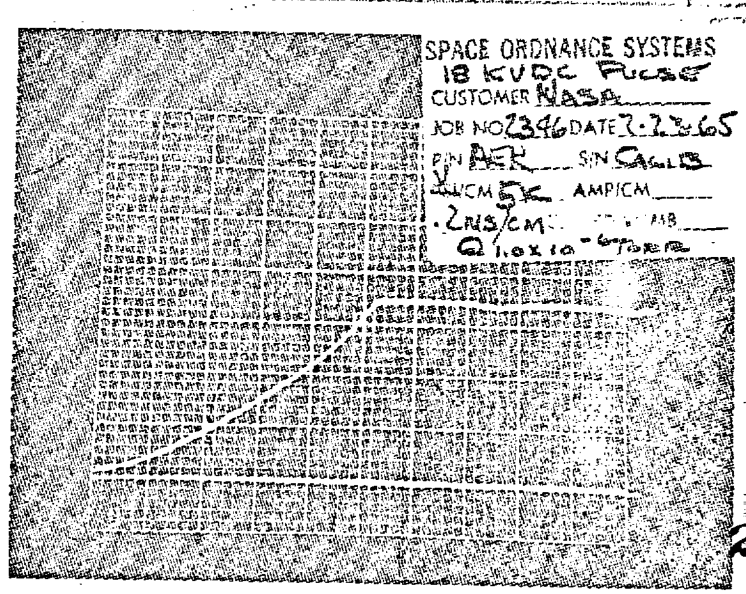

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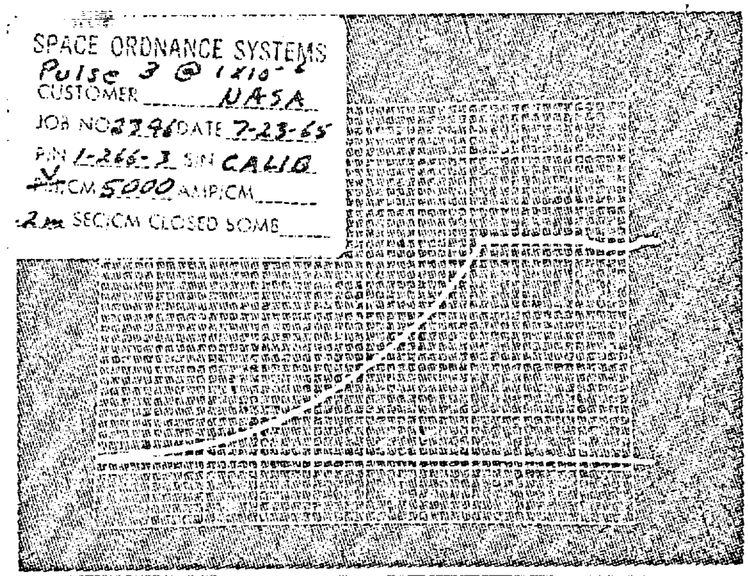

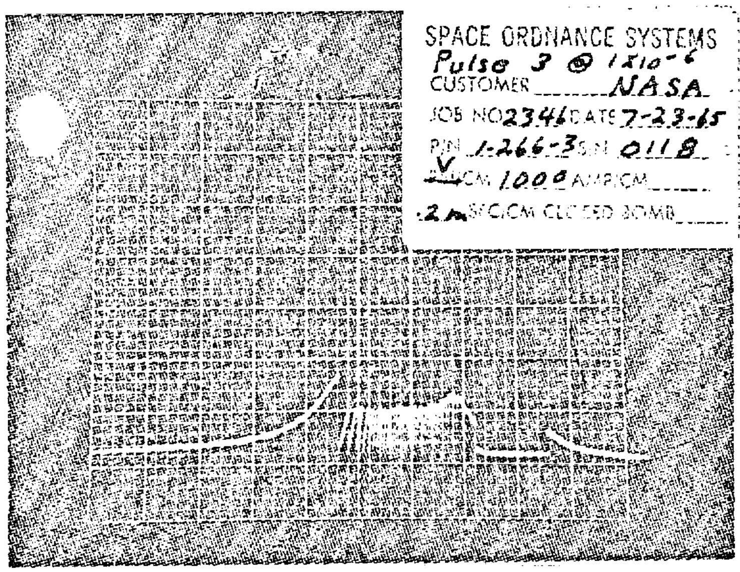

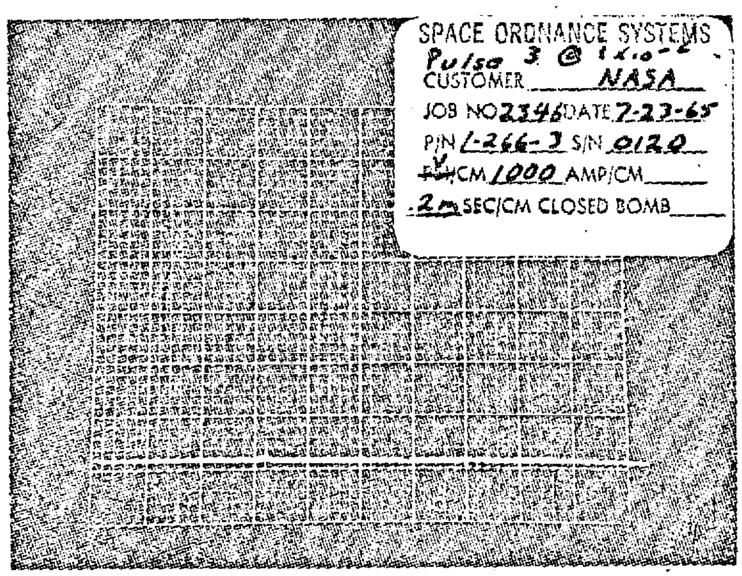

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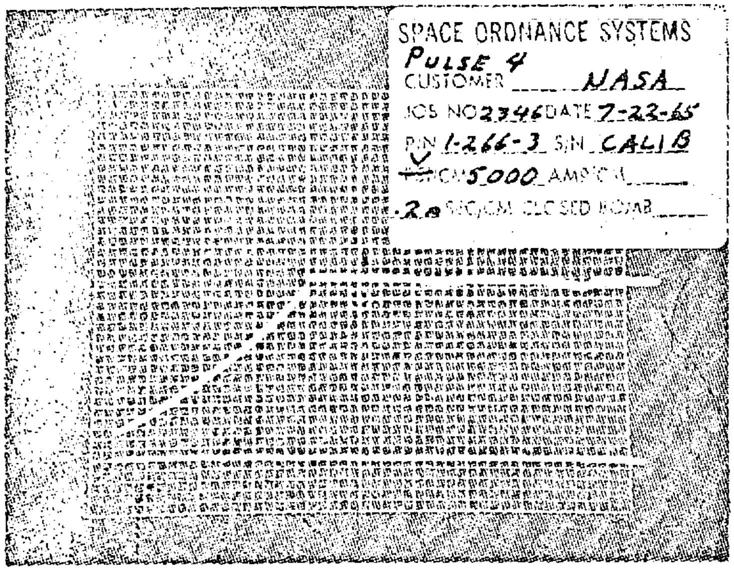

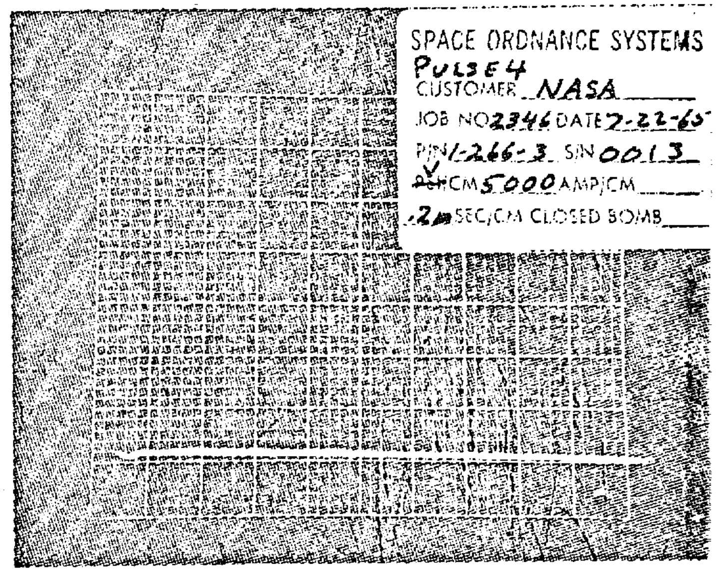

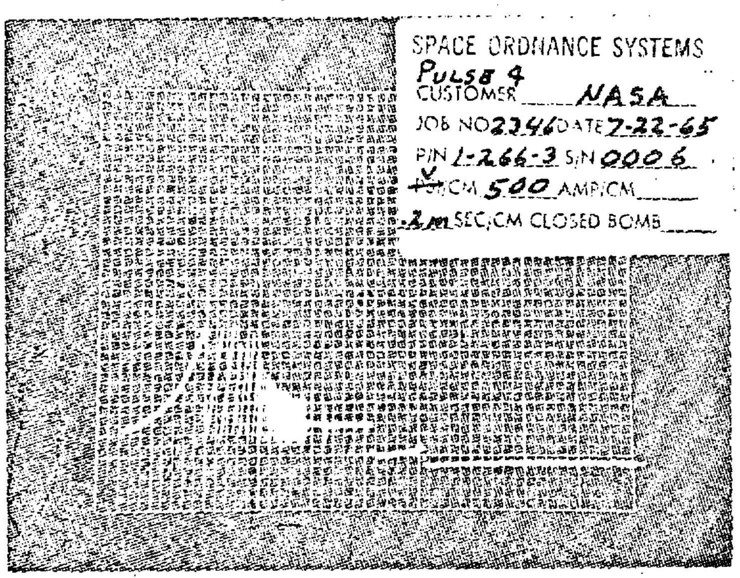

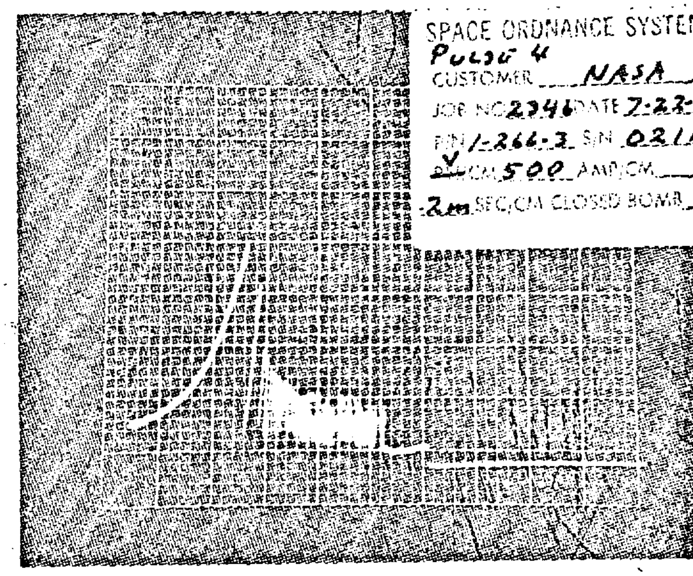

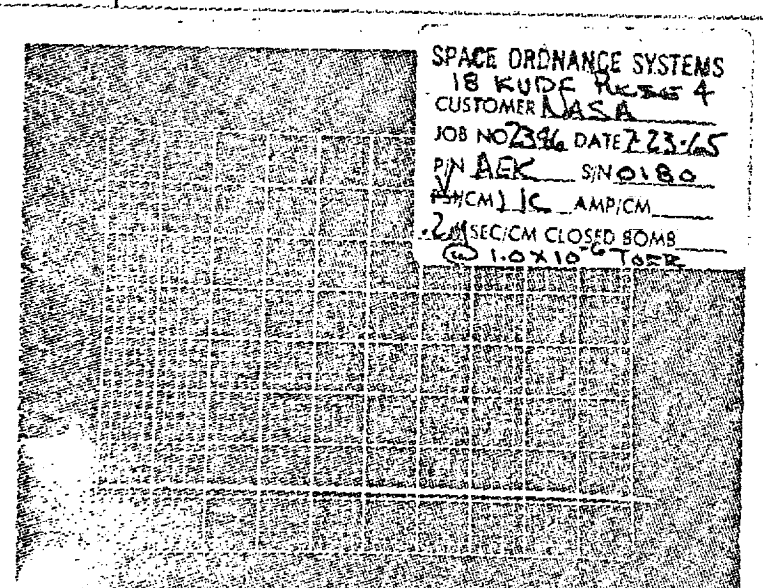

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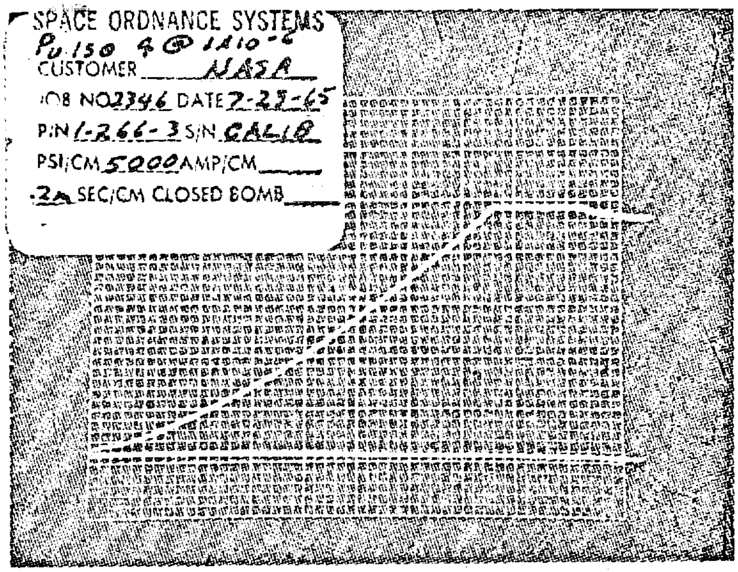

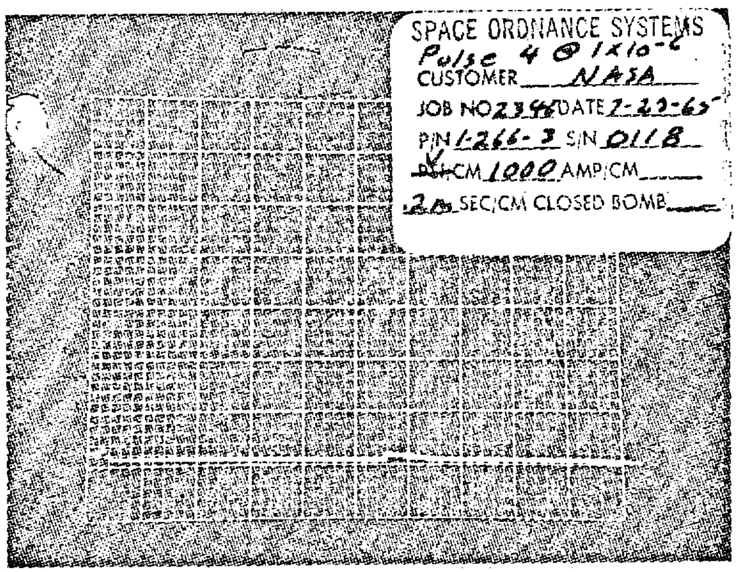

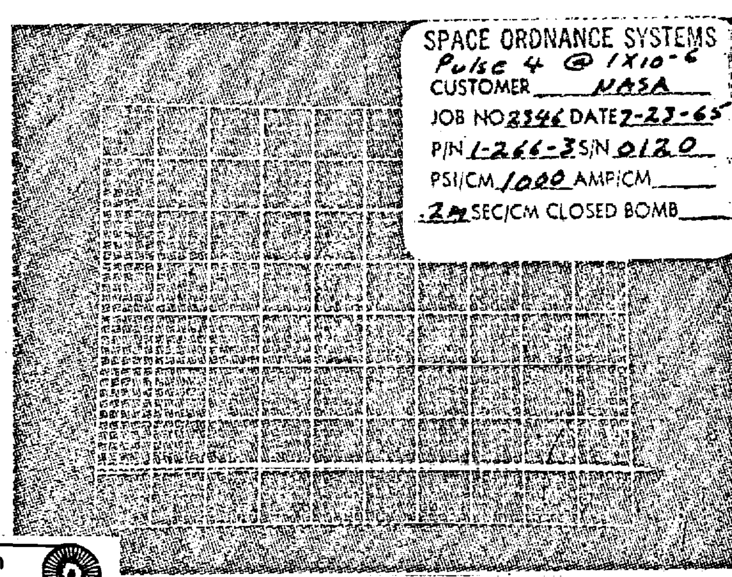

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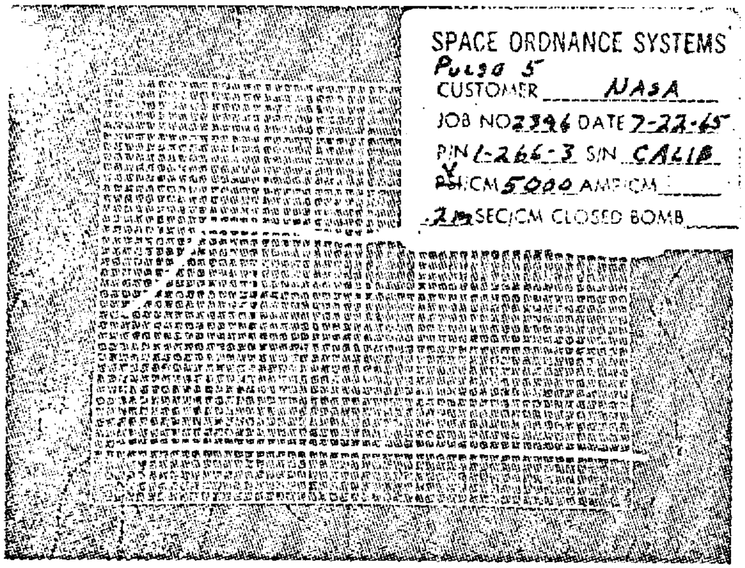

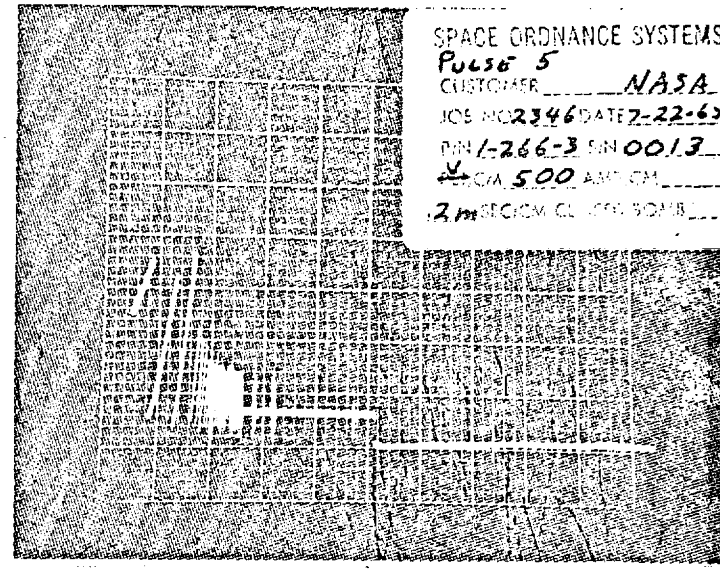

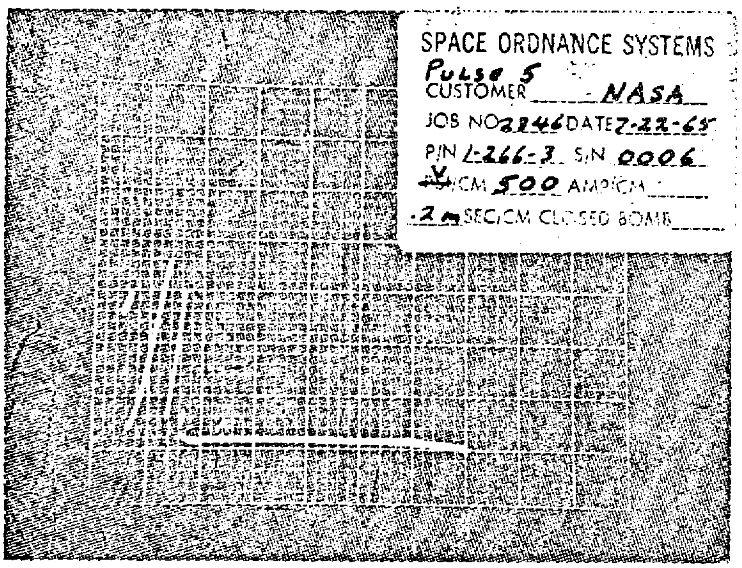

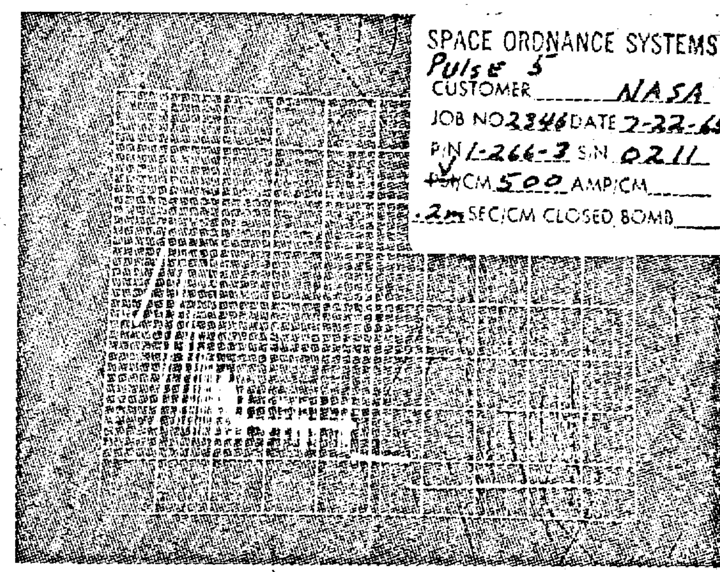

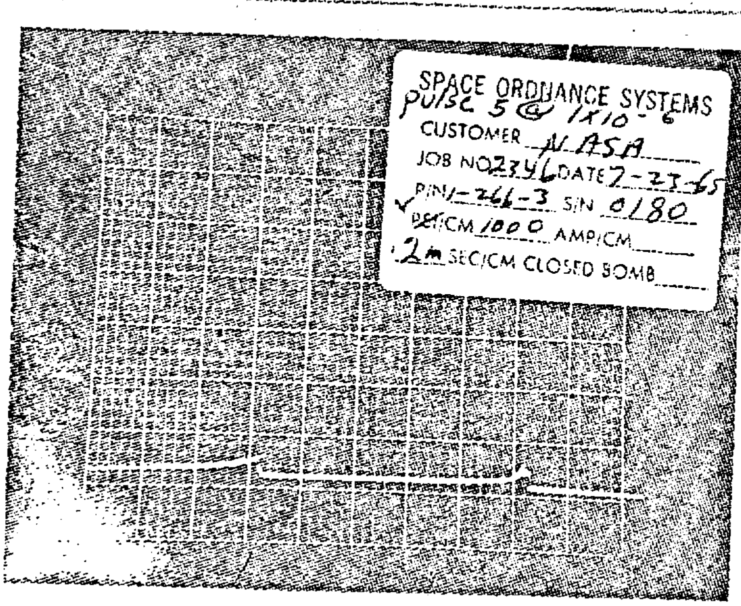

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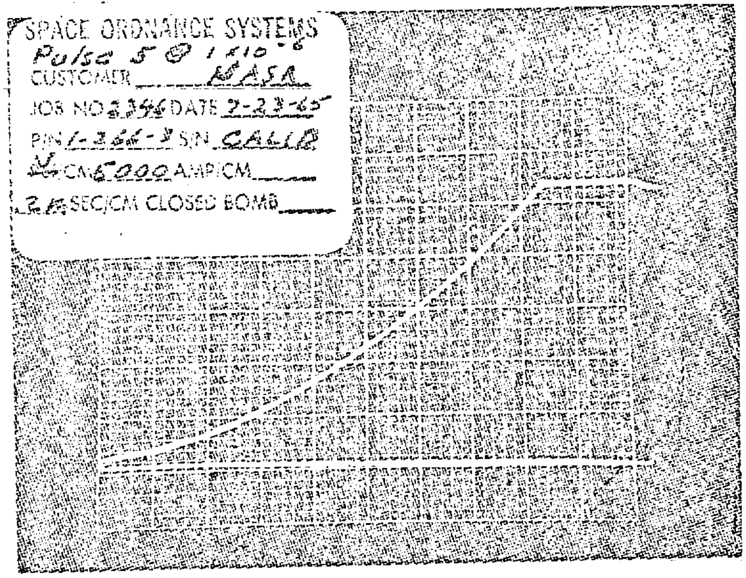

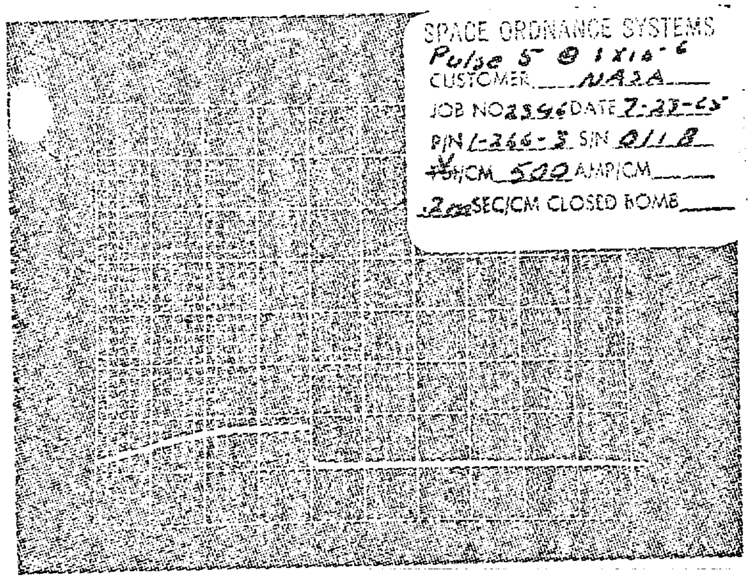

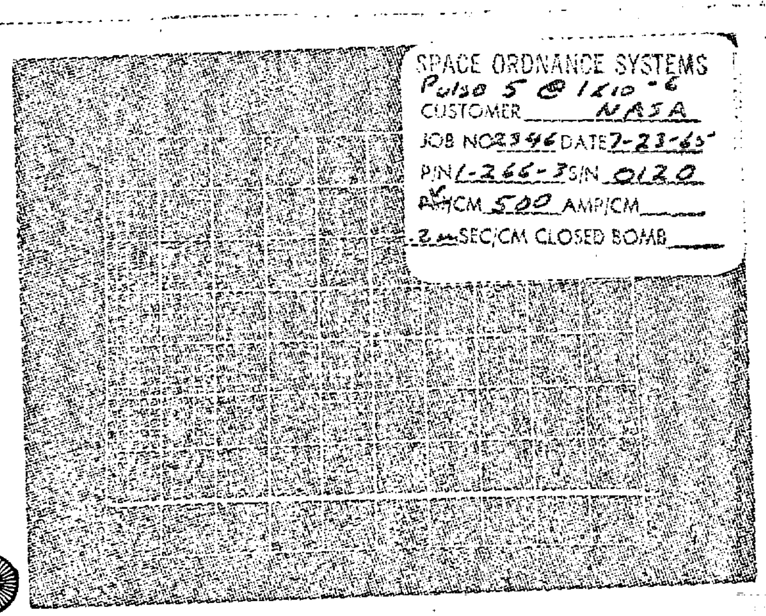

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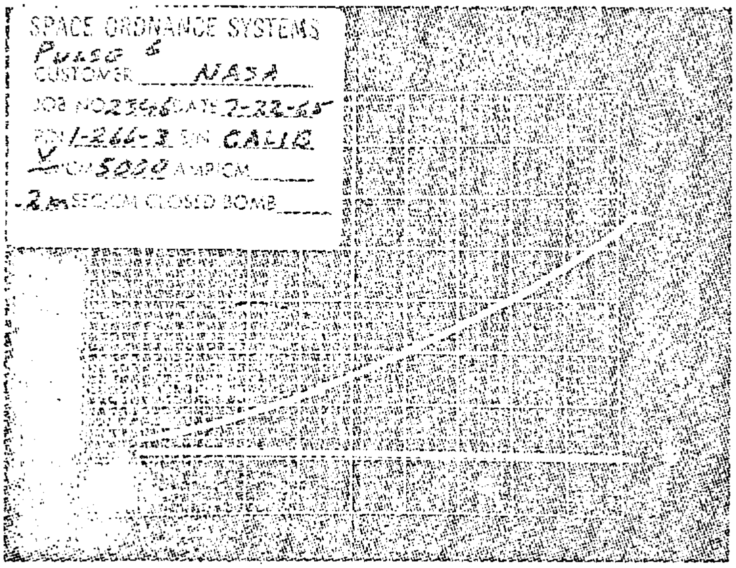

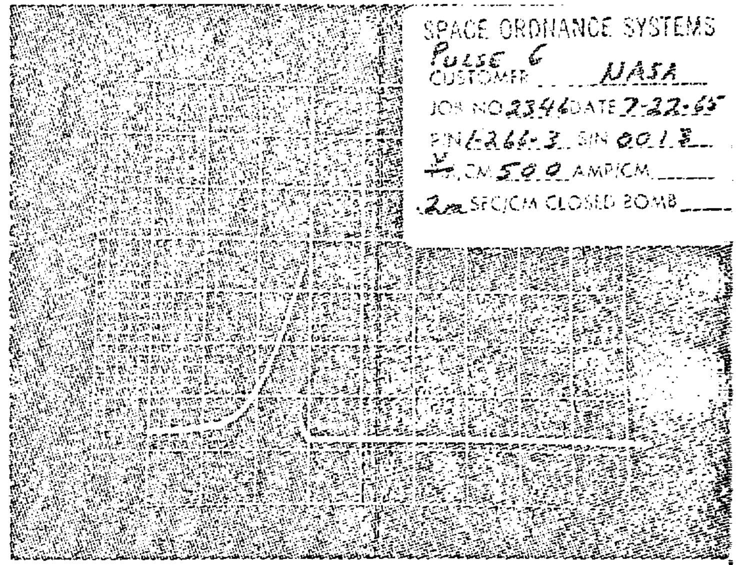

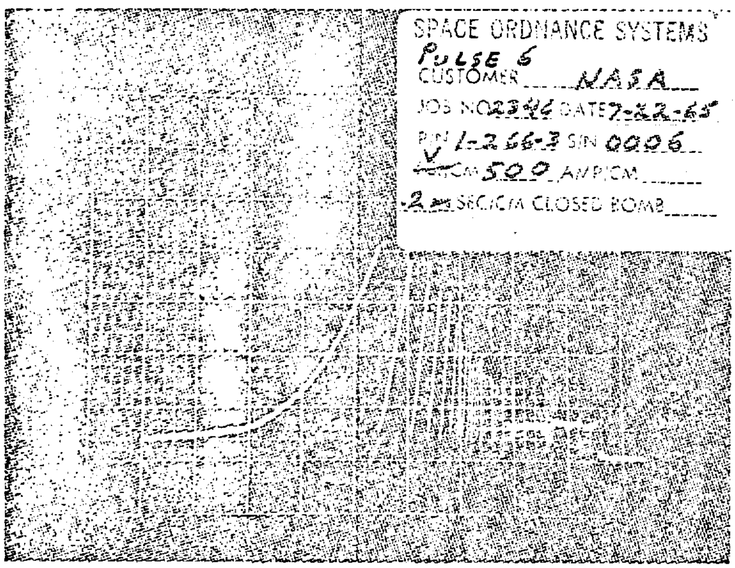

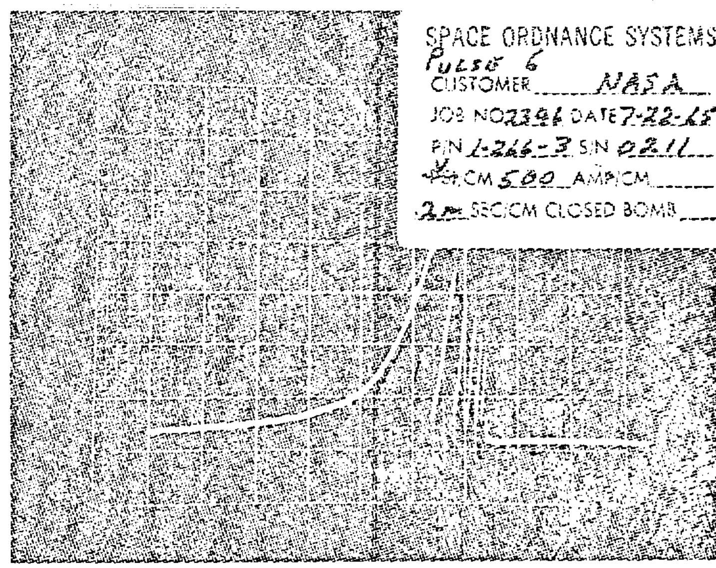

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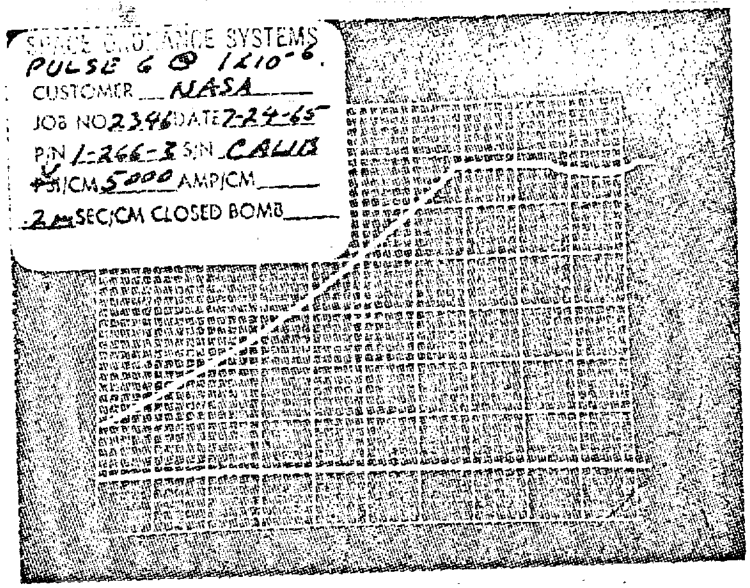

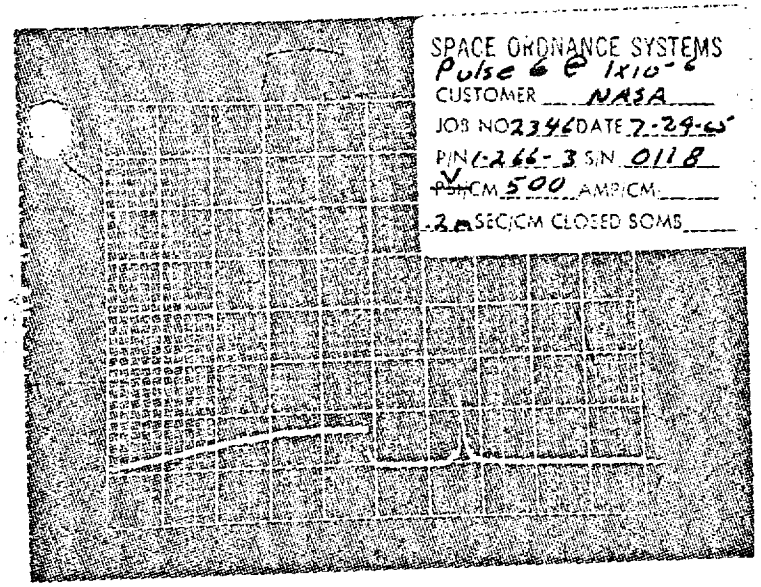

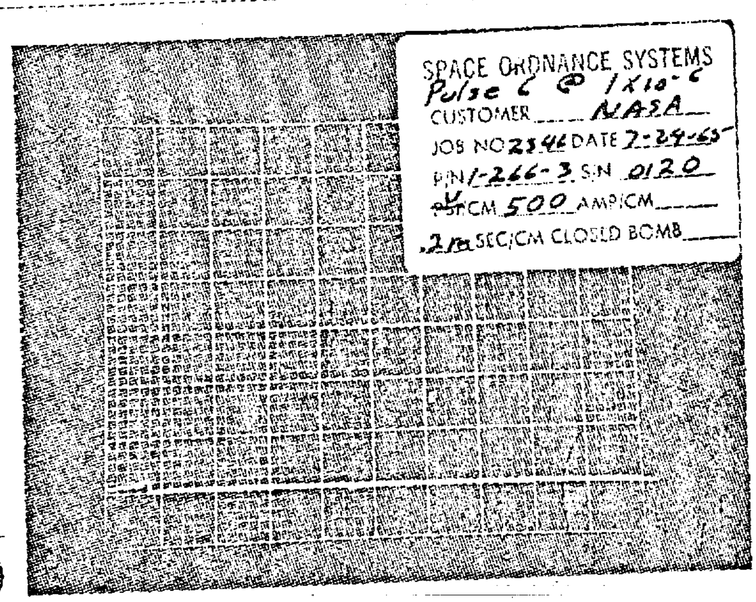

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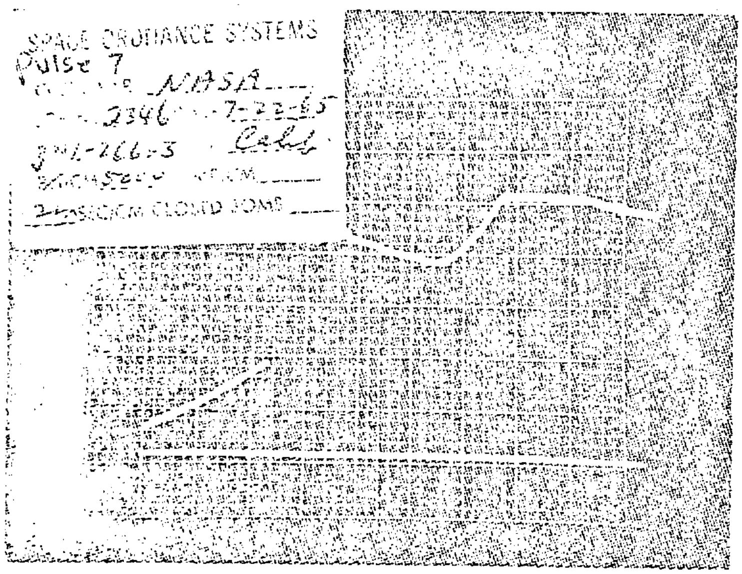

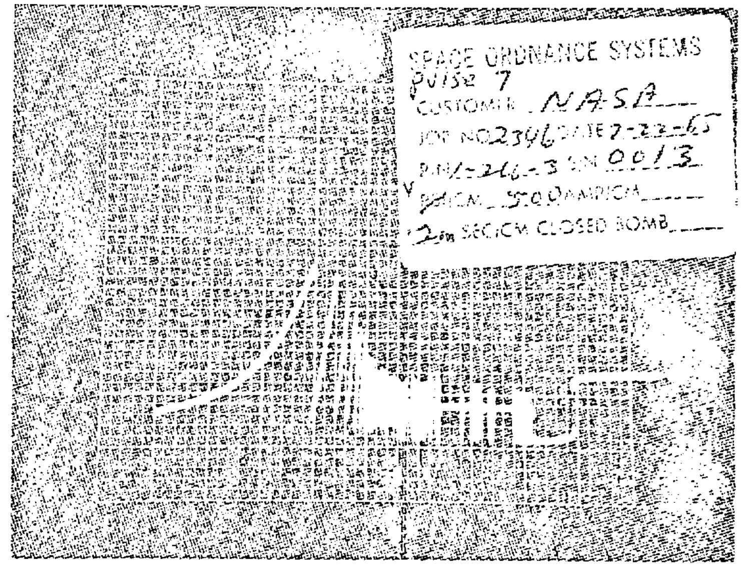

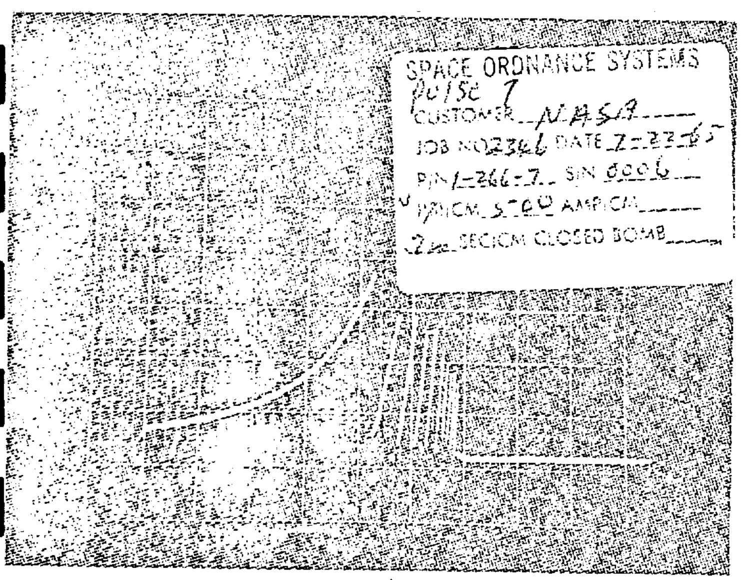

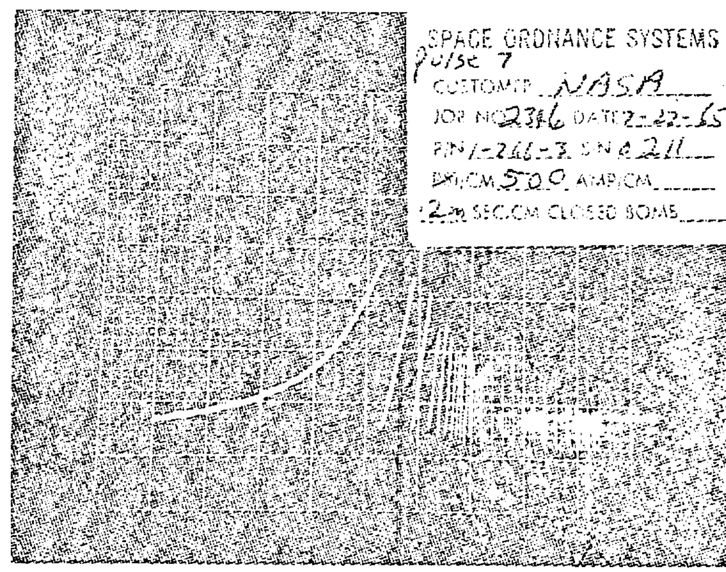

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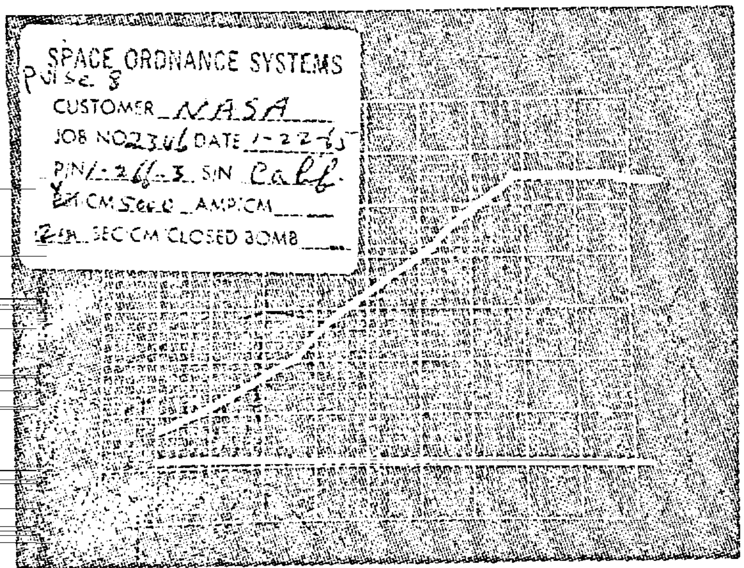

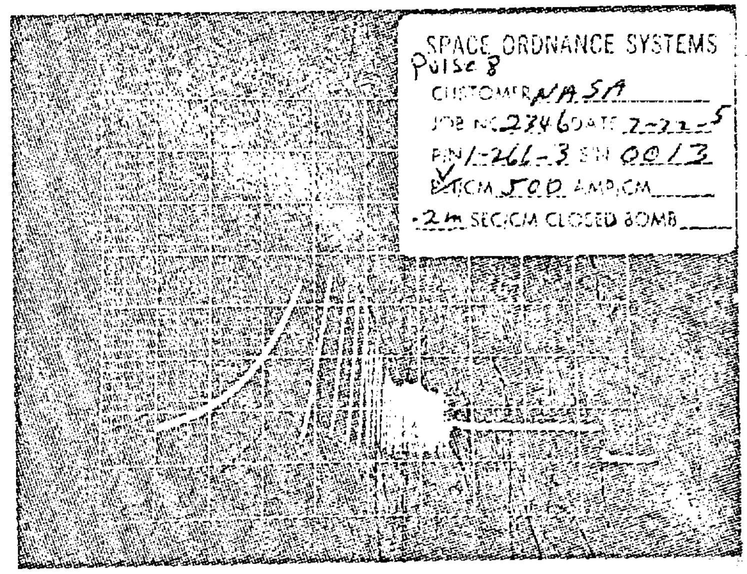

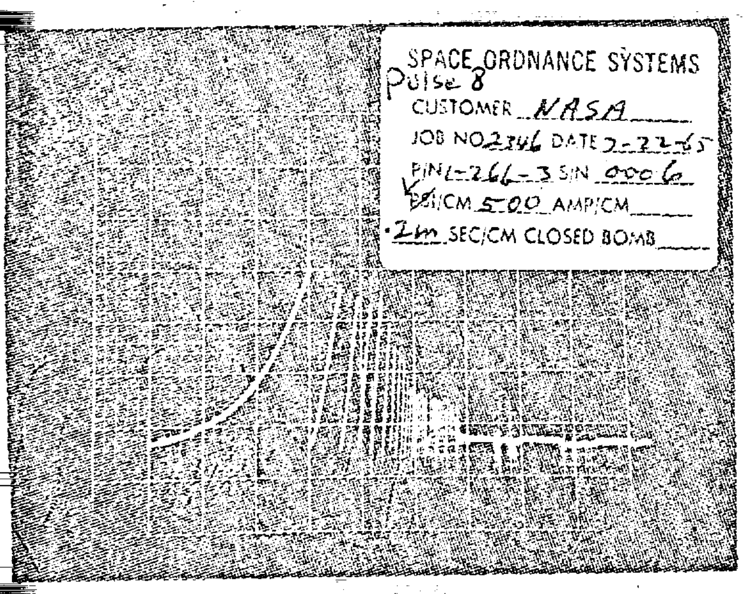

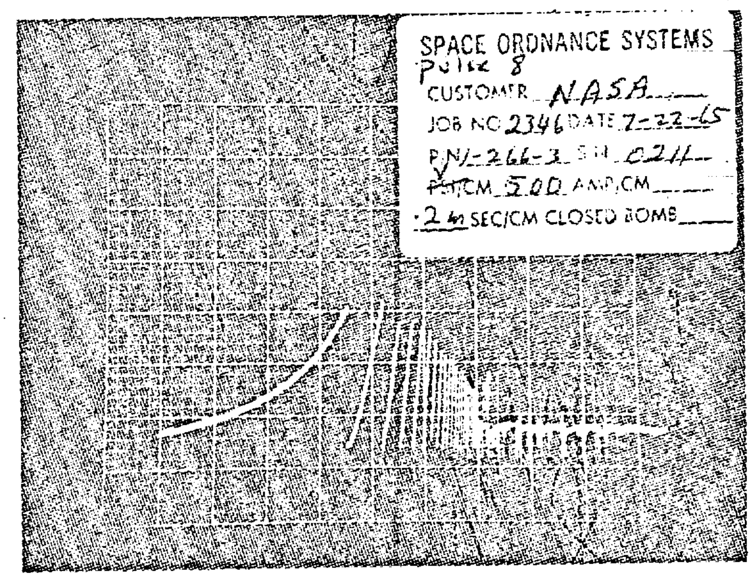

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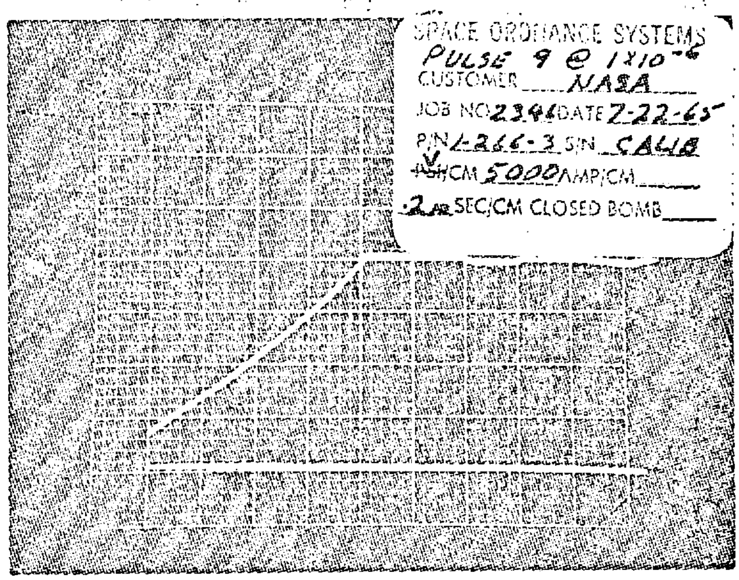

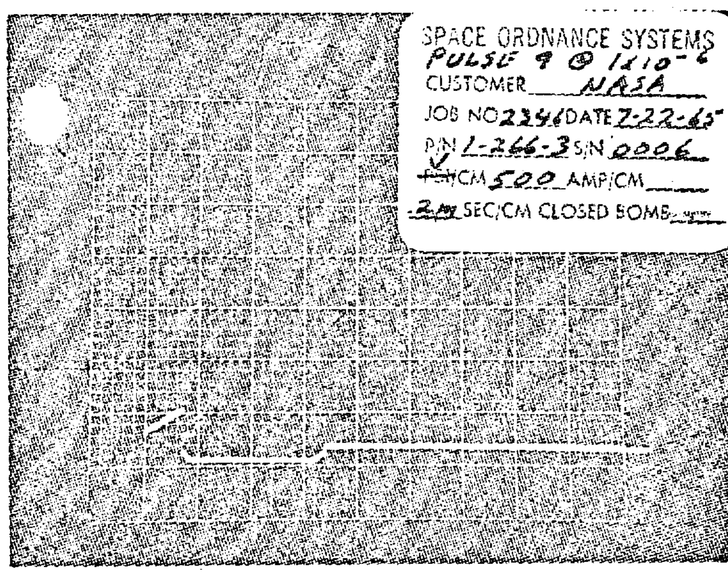

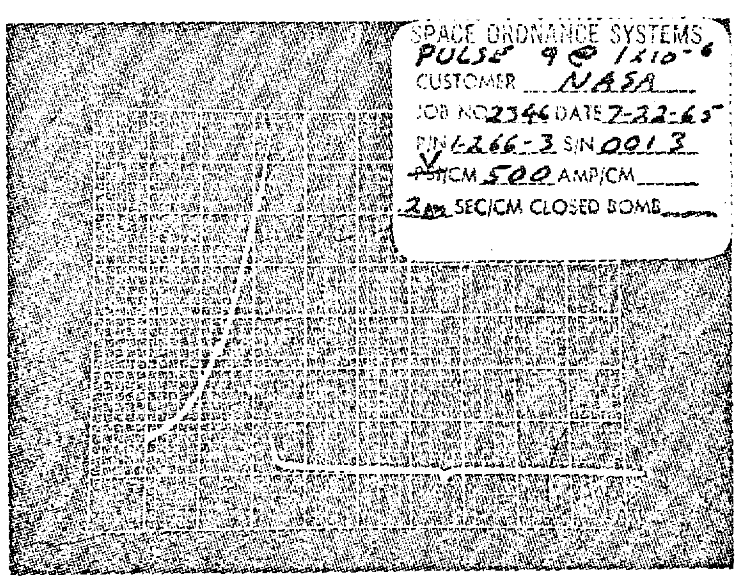

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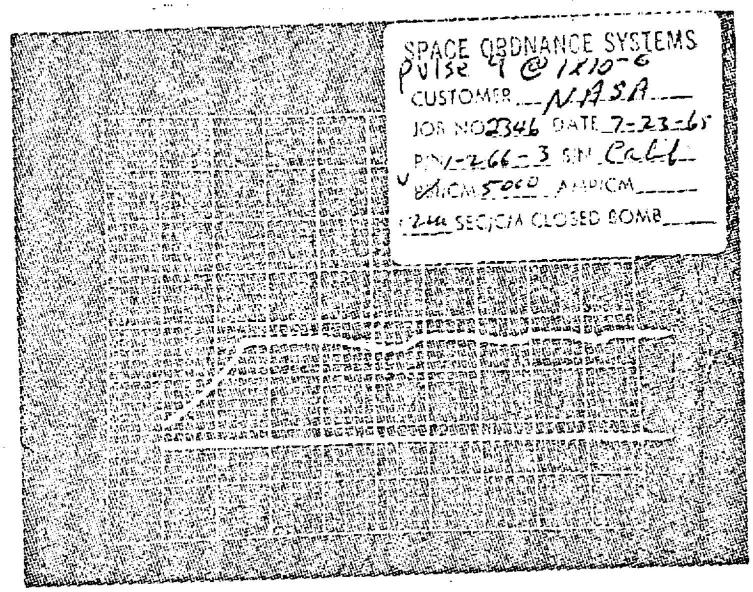

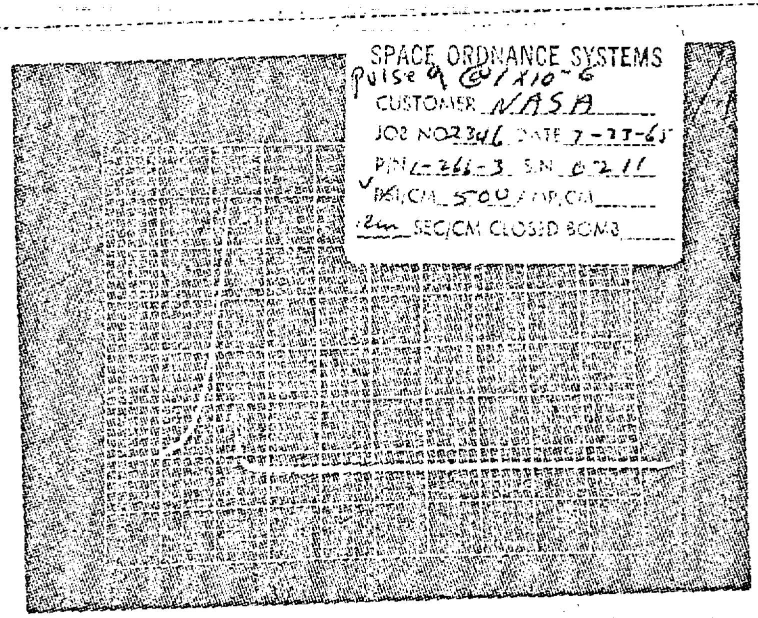

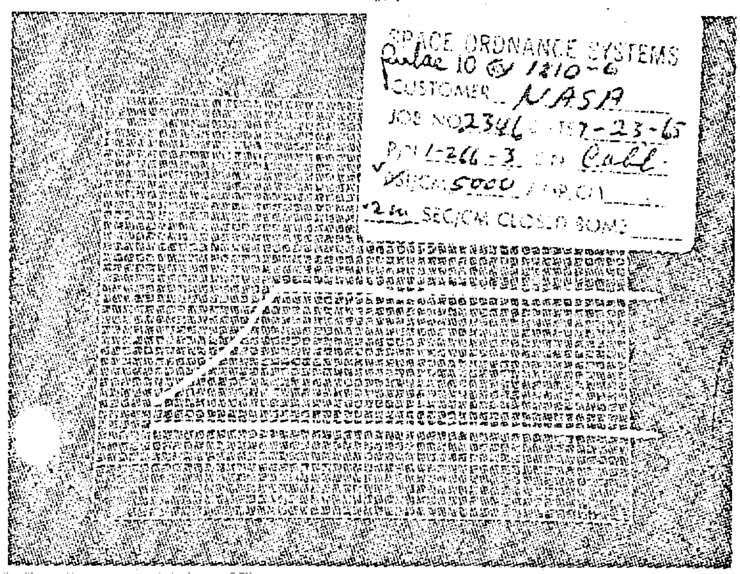
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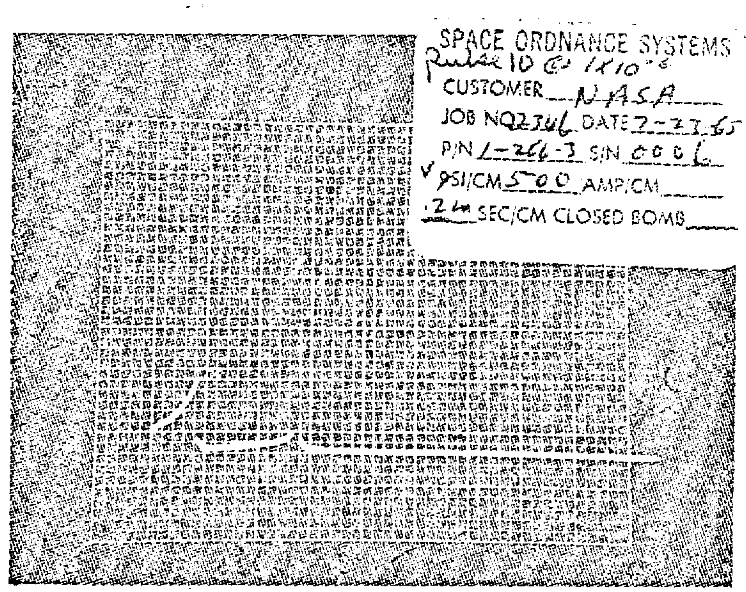
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CONCEPT TESTING

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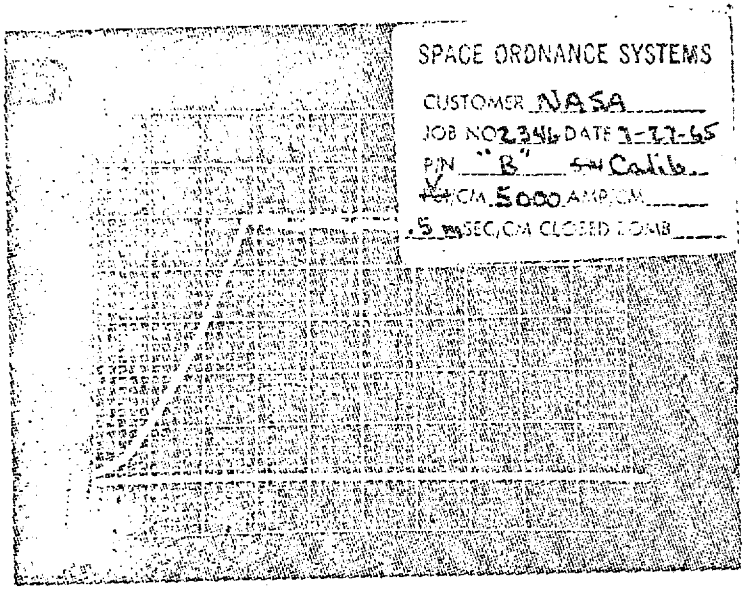

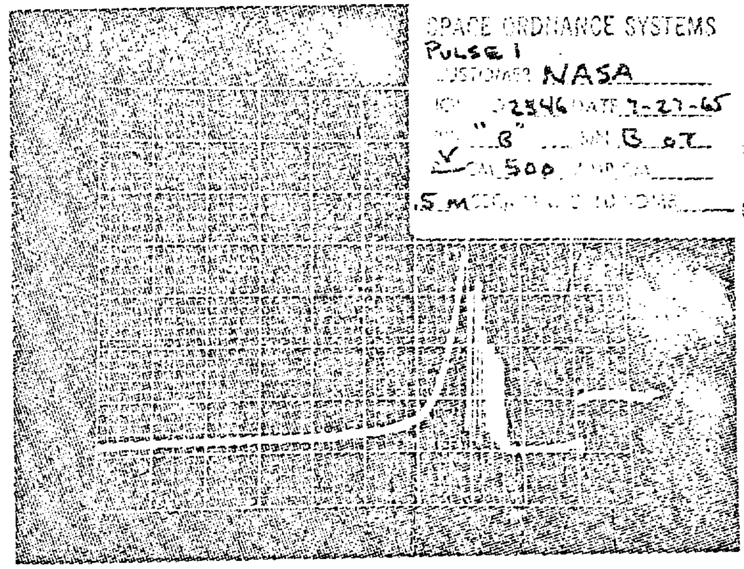

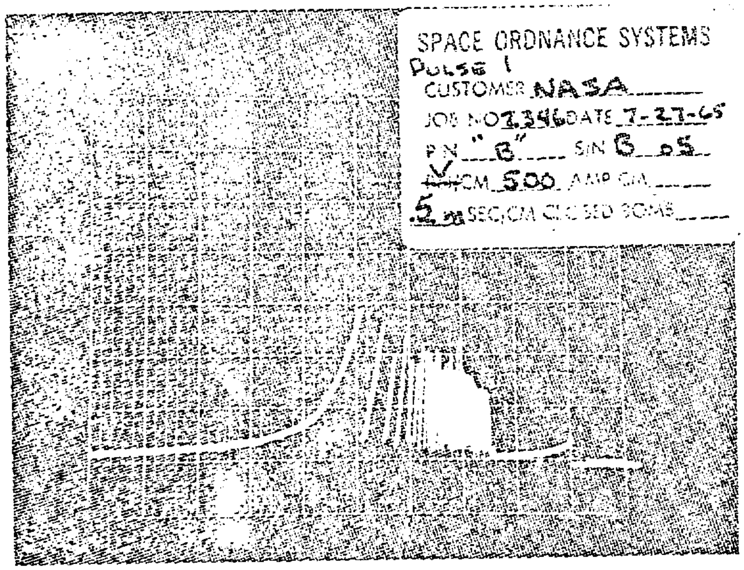

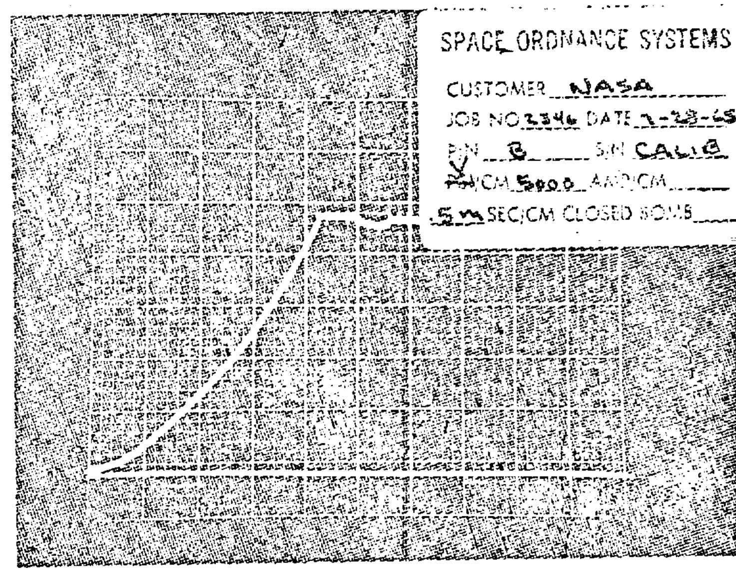

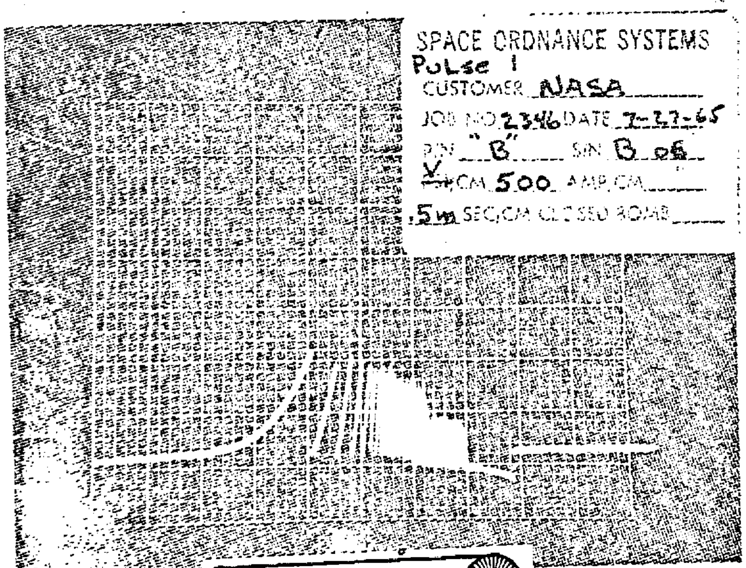

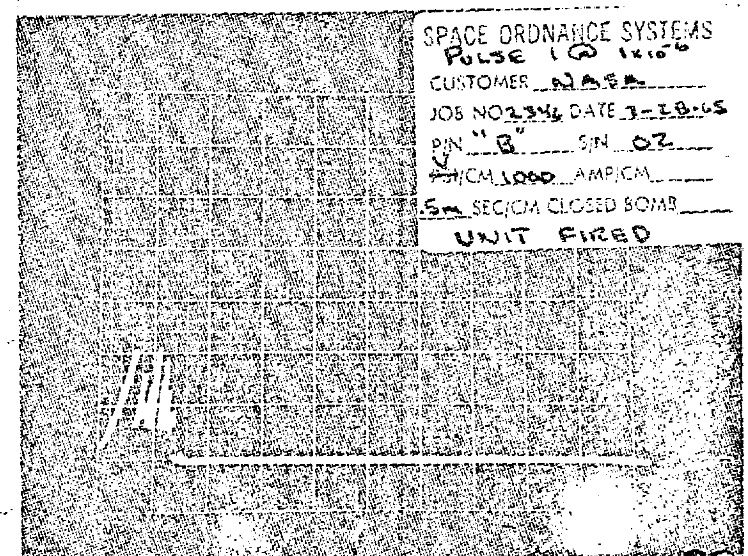

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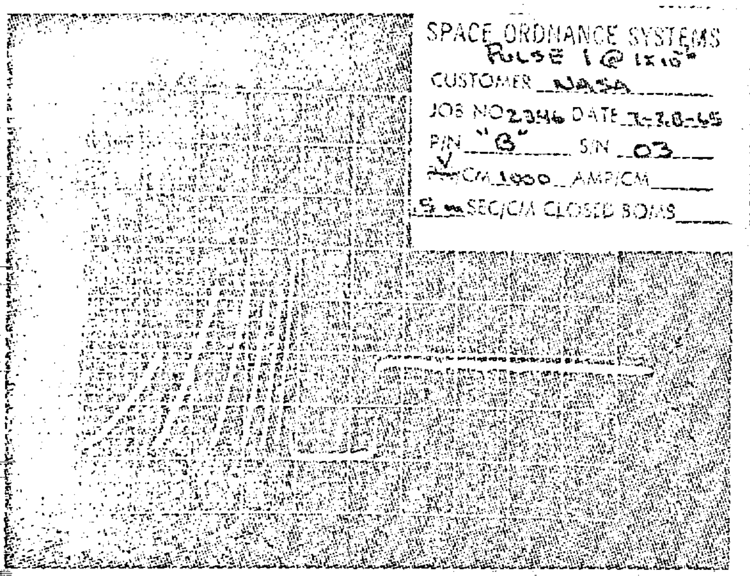

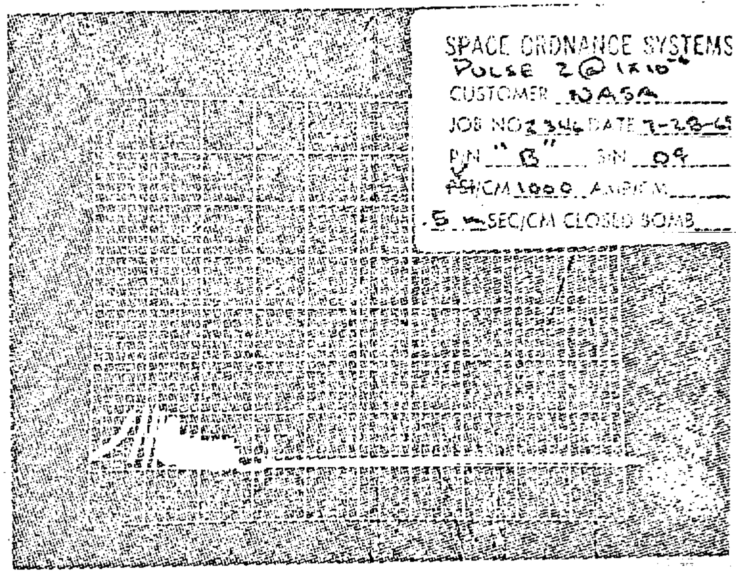

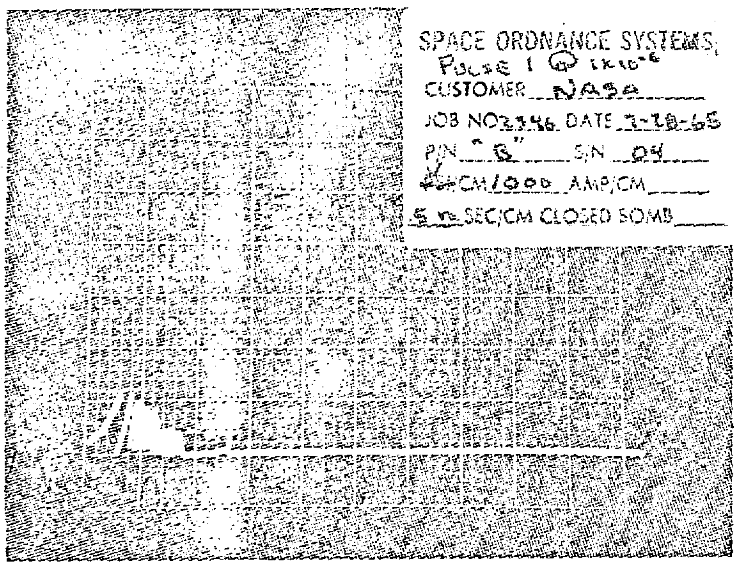

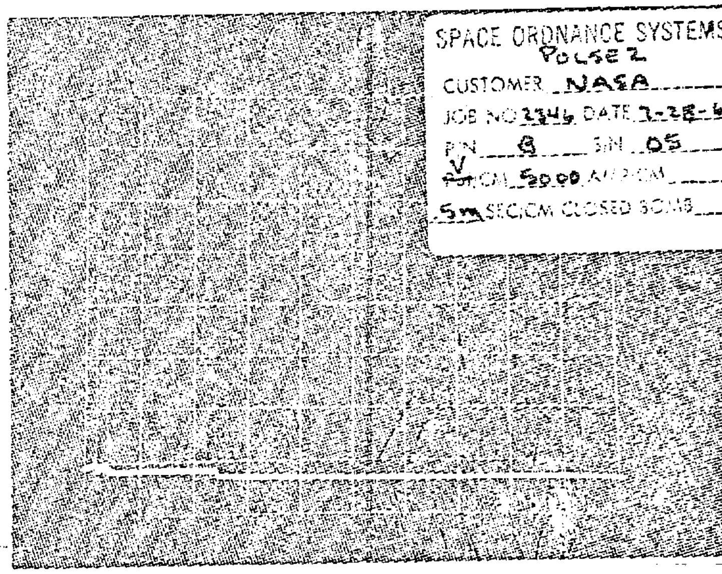

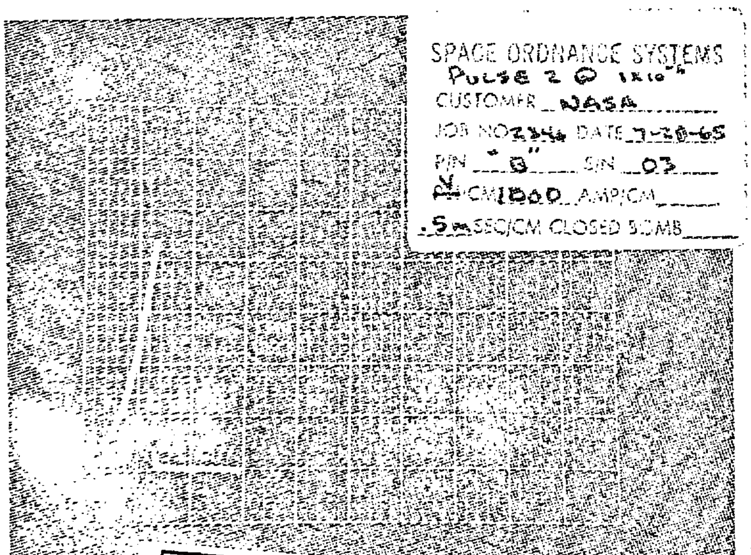

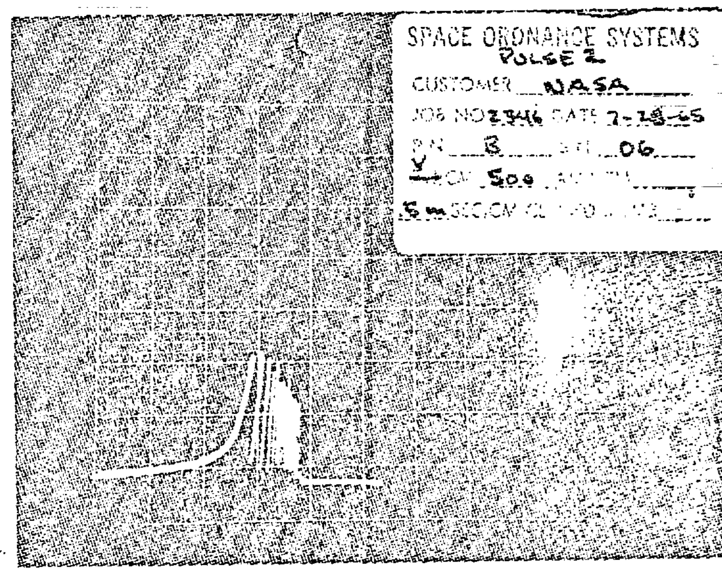

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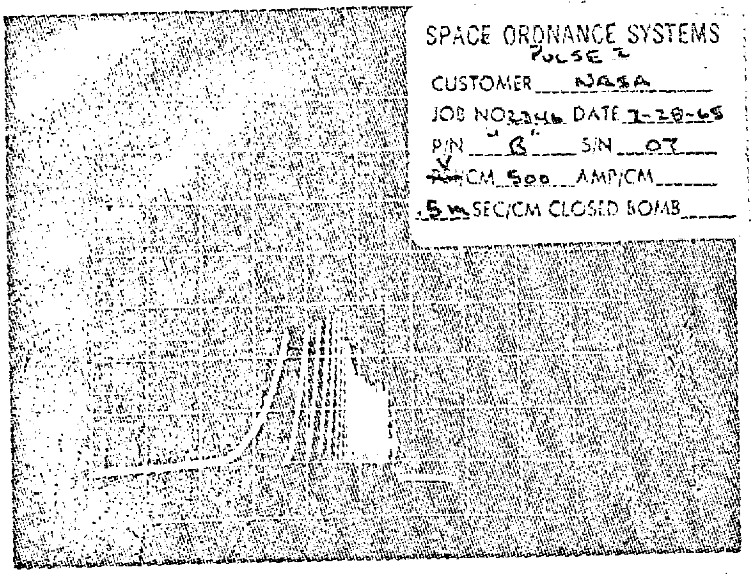

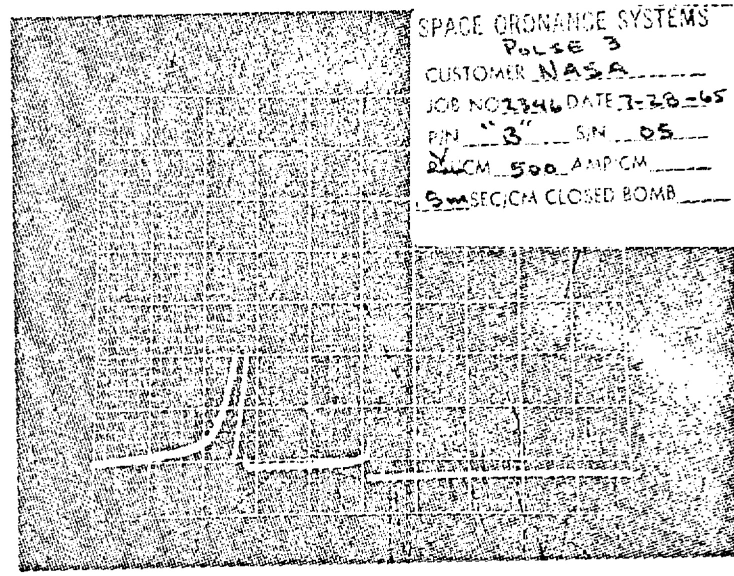

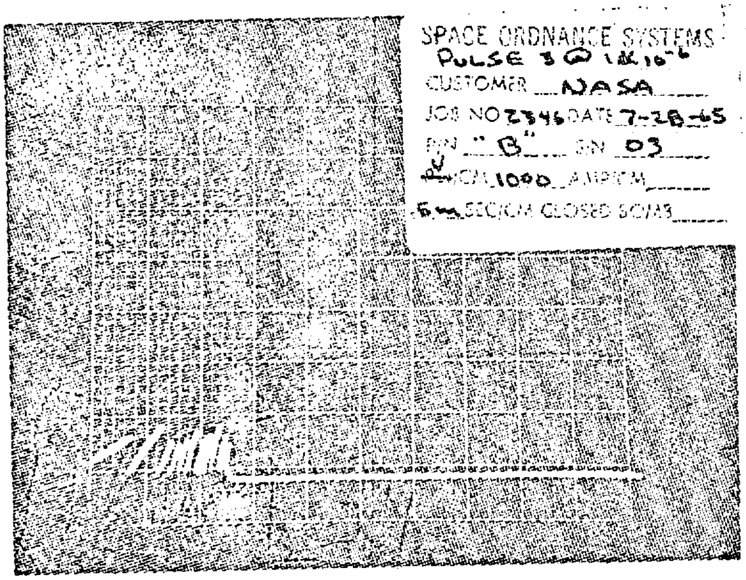

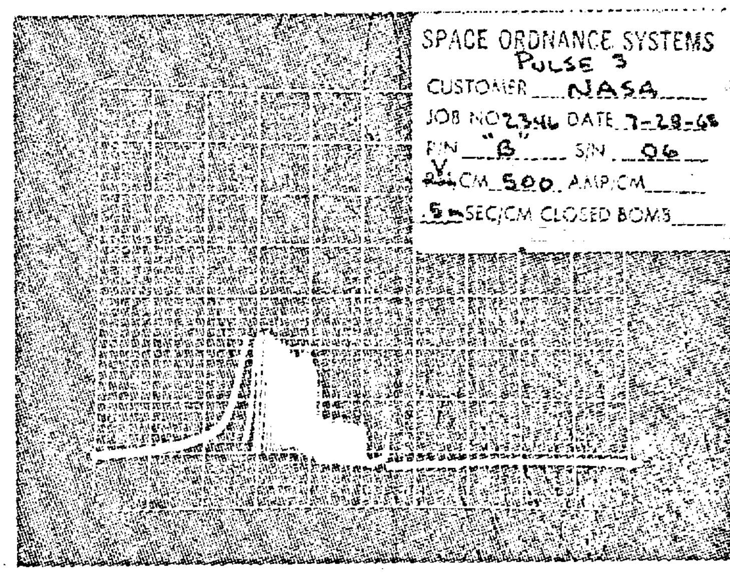

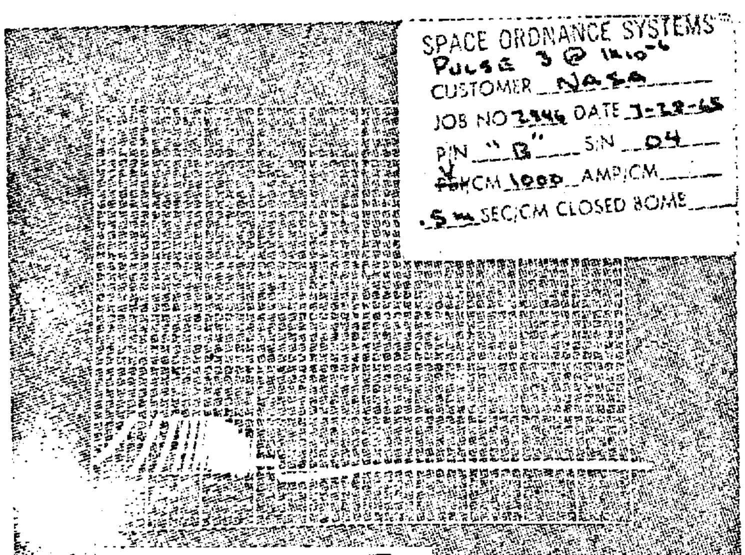

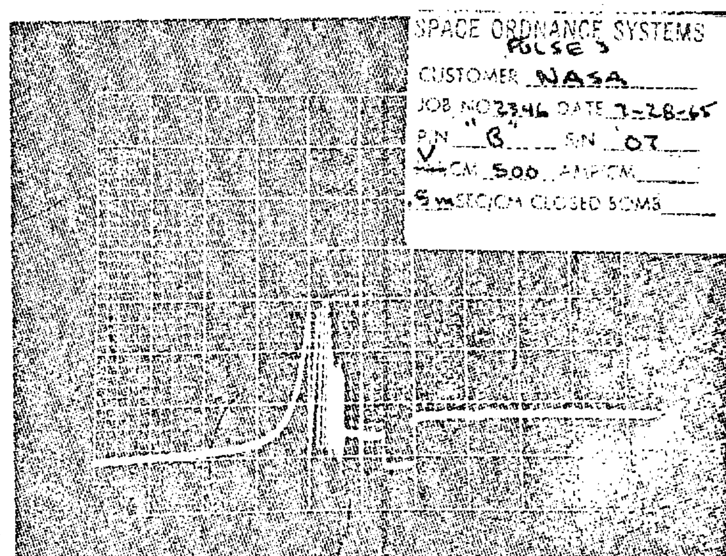

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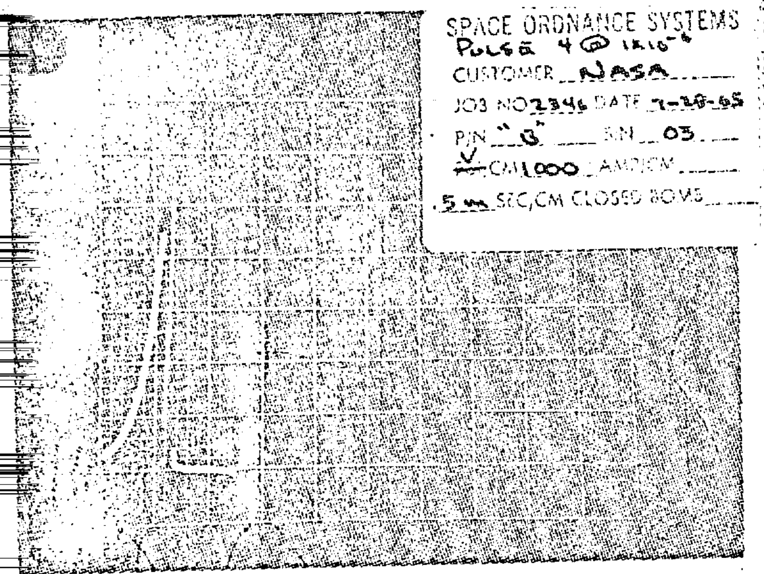

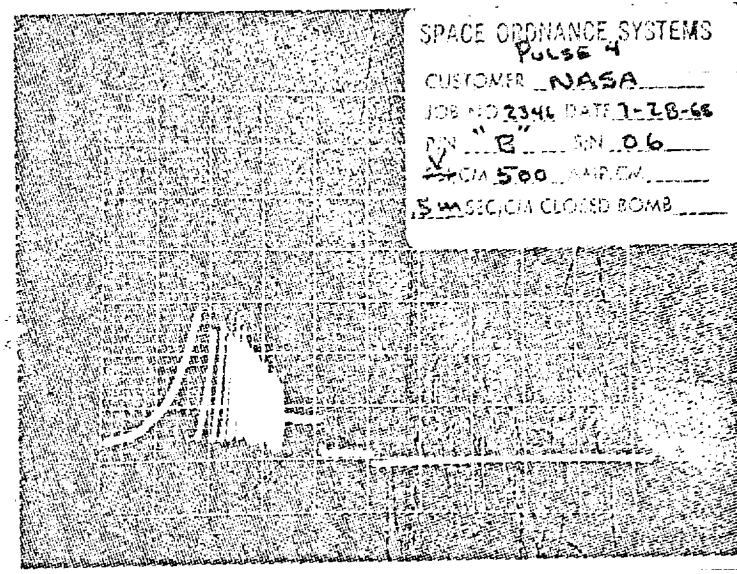

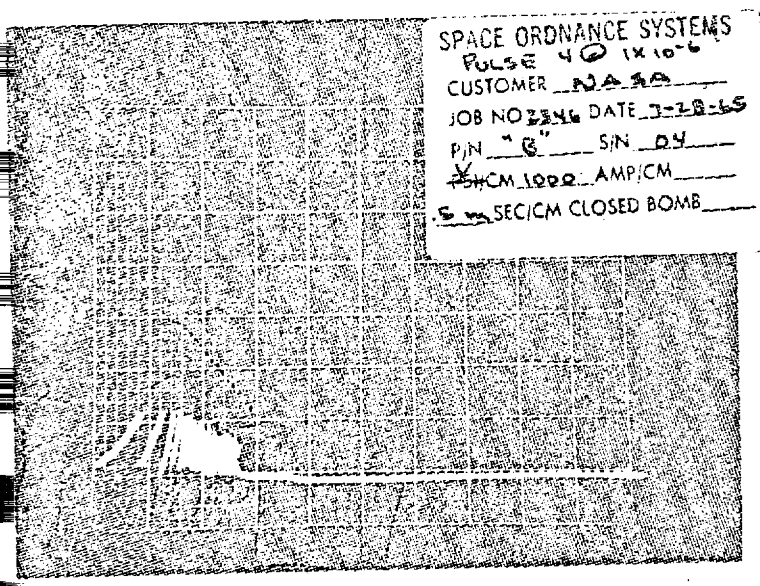

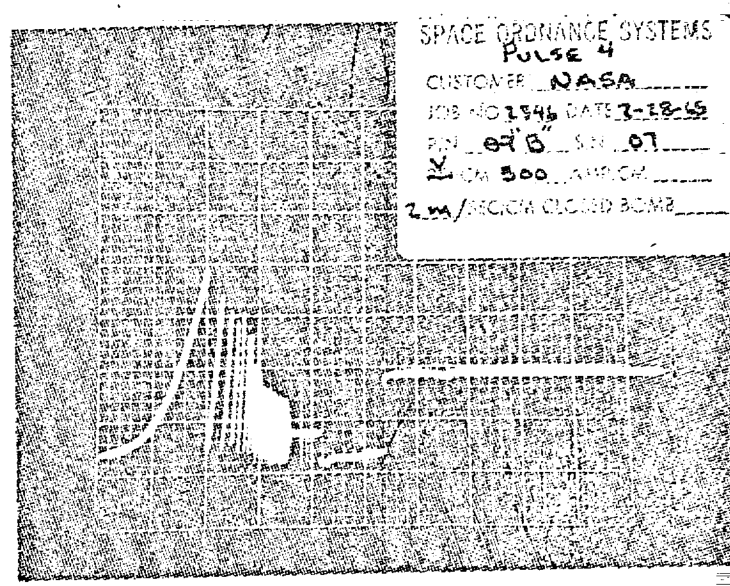

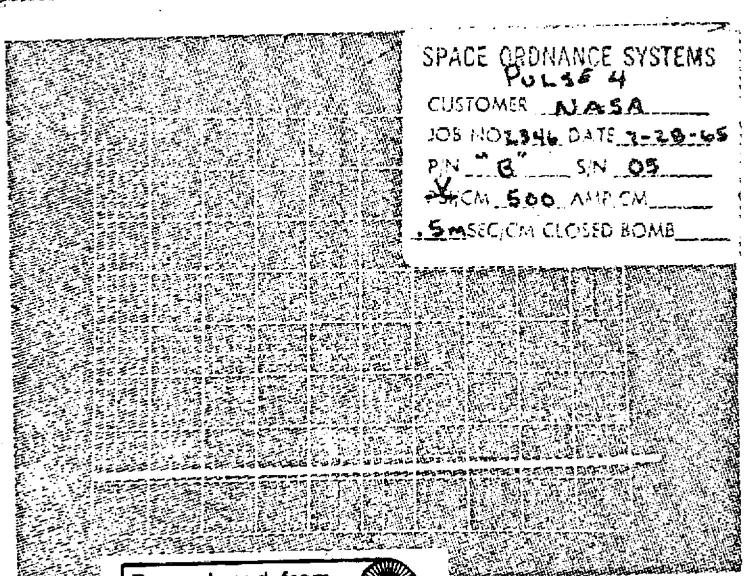

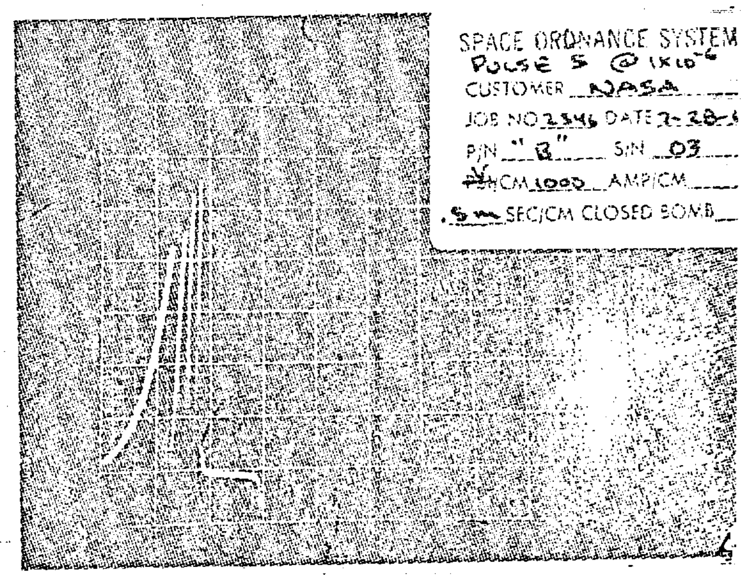

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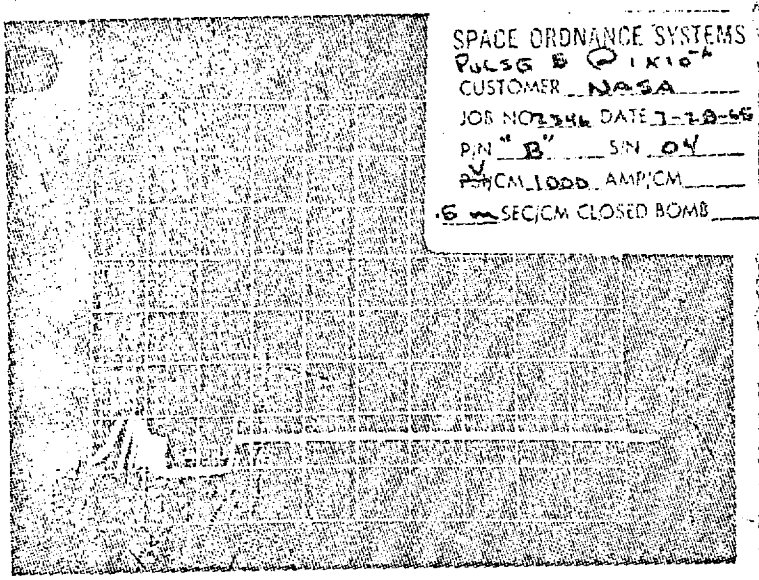

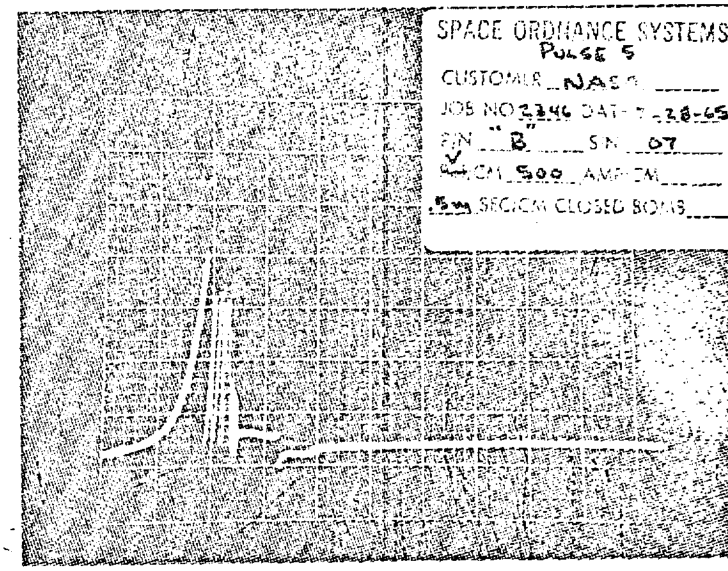

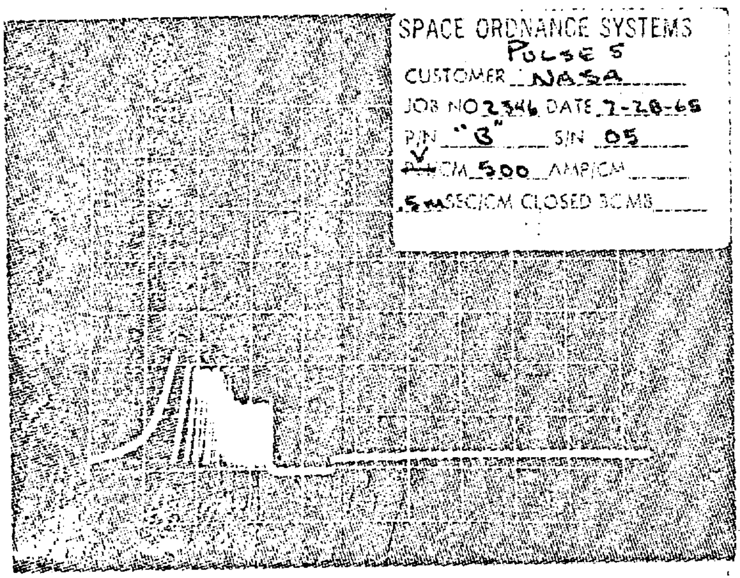

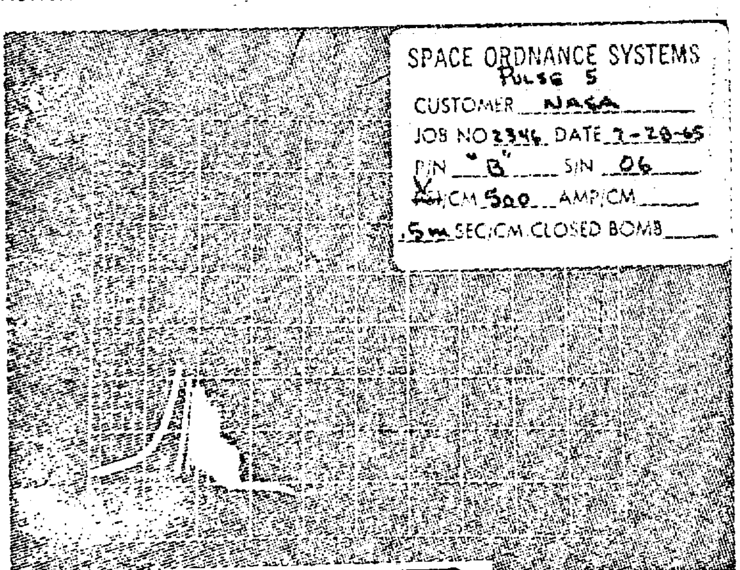

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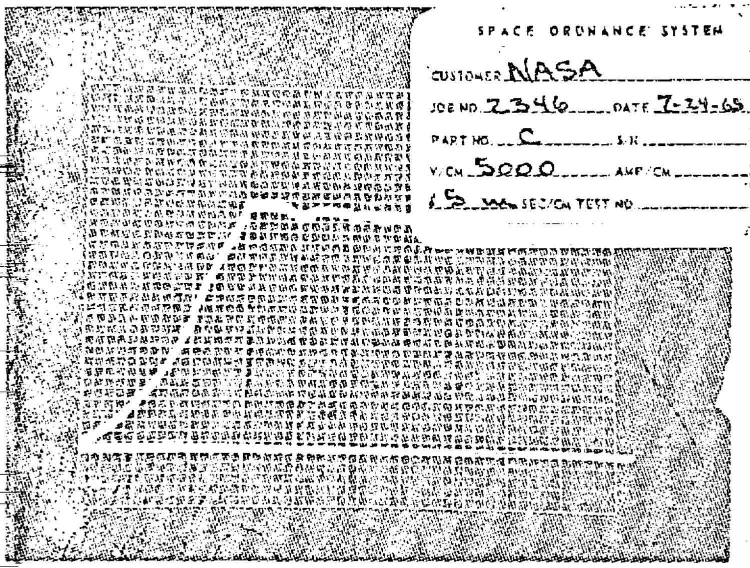

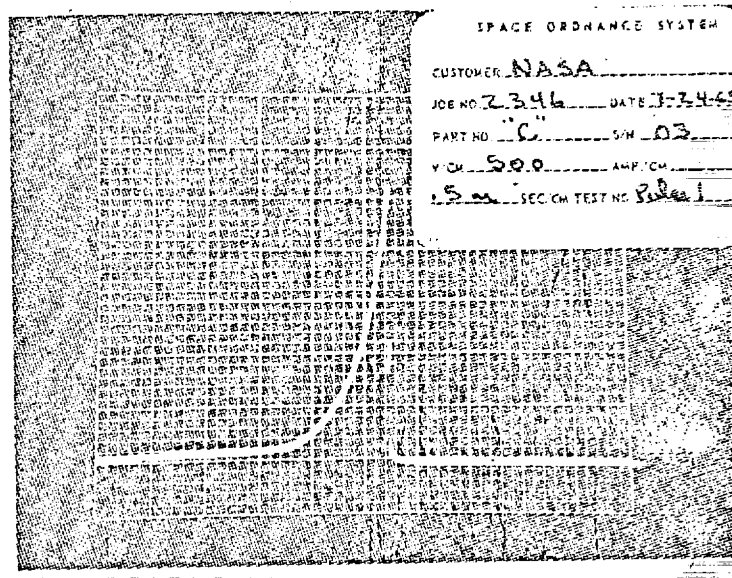

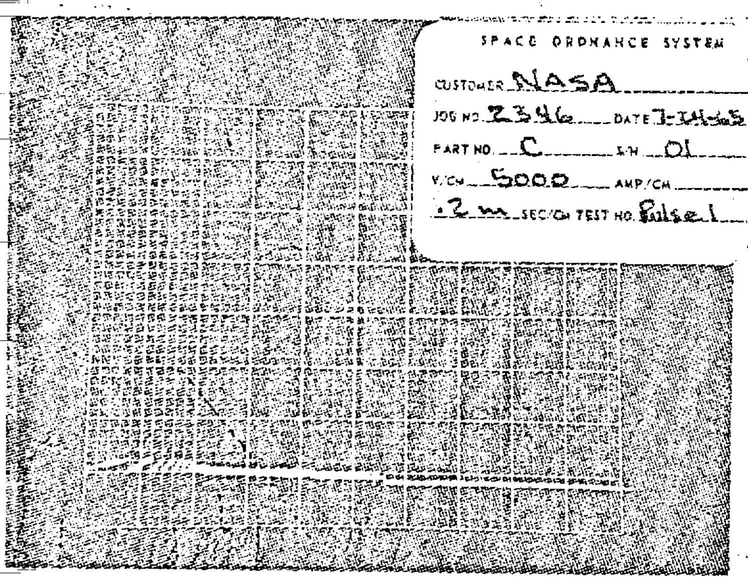

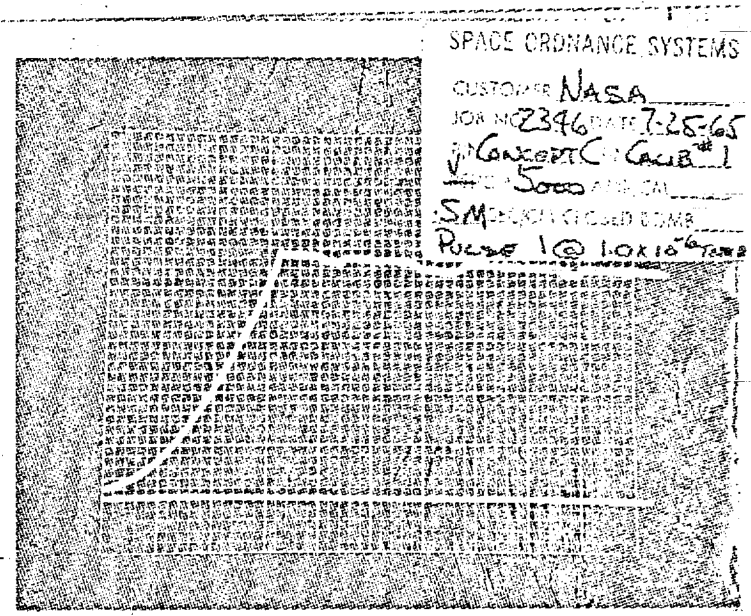

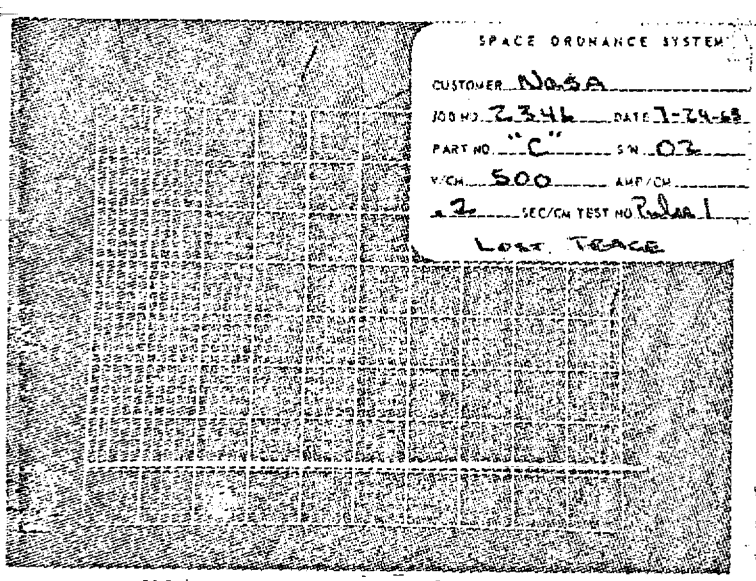

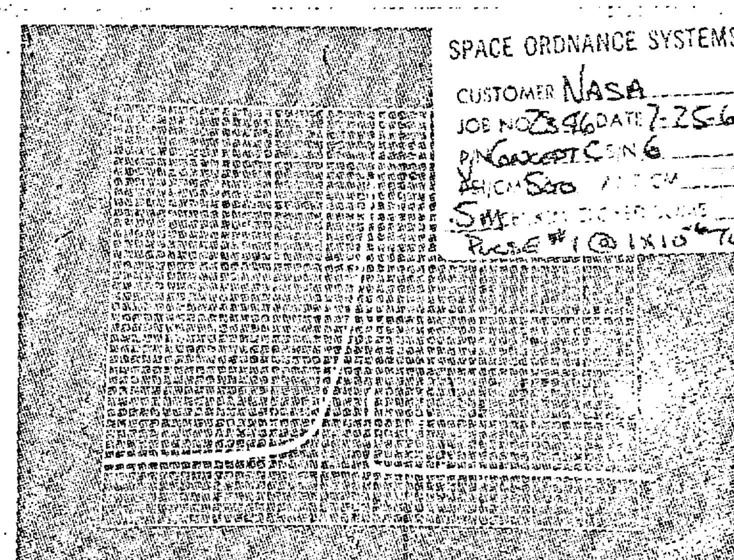

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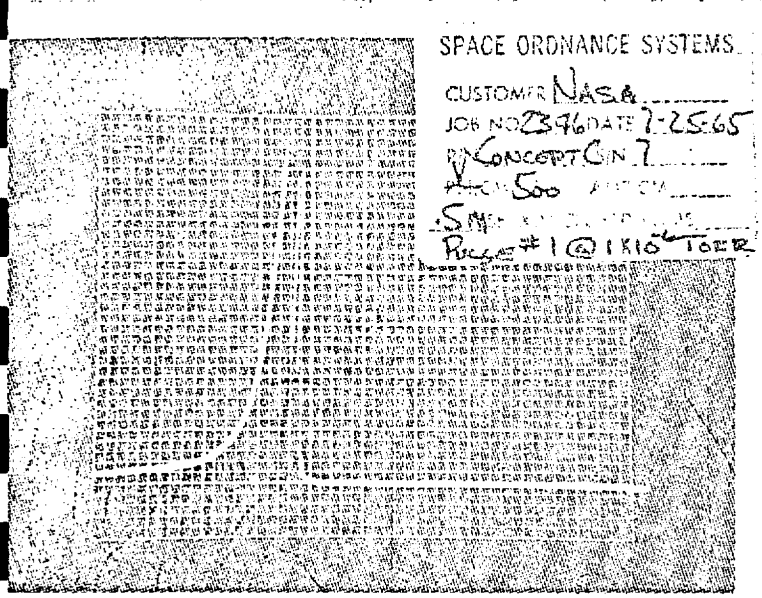

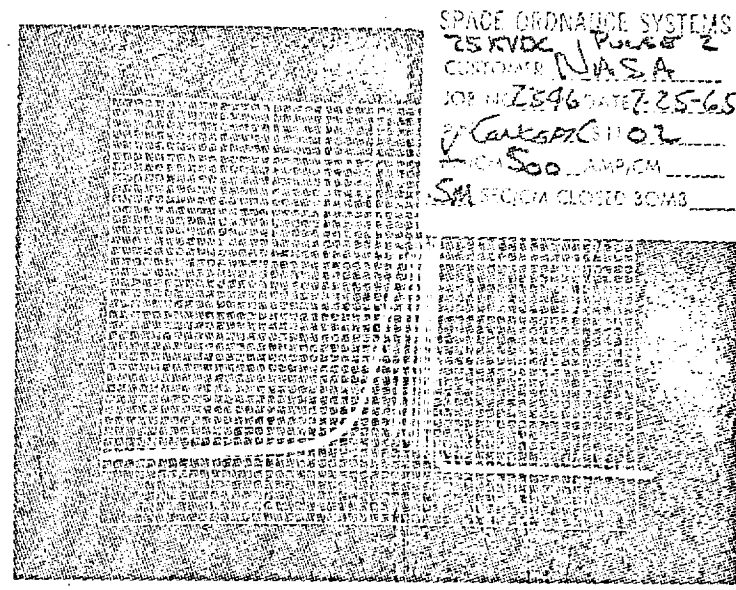

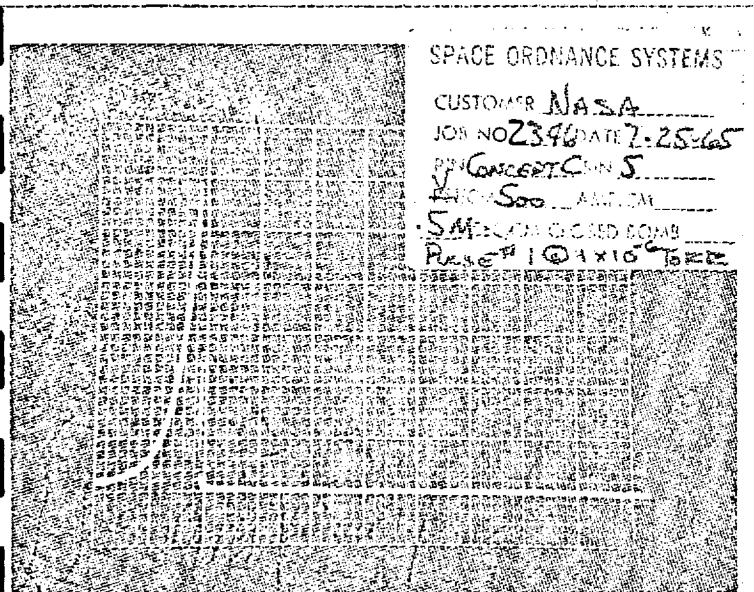

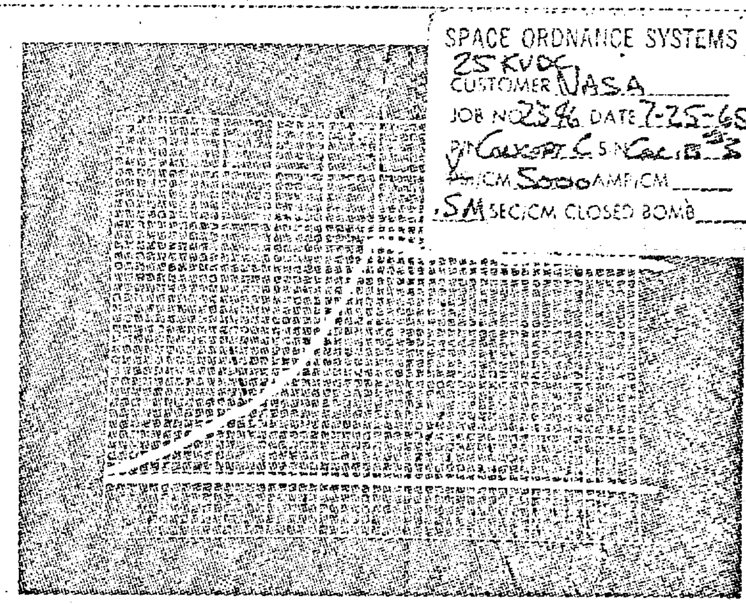

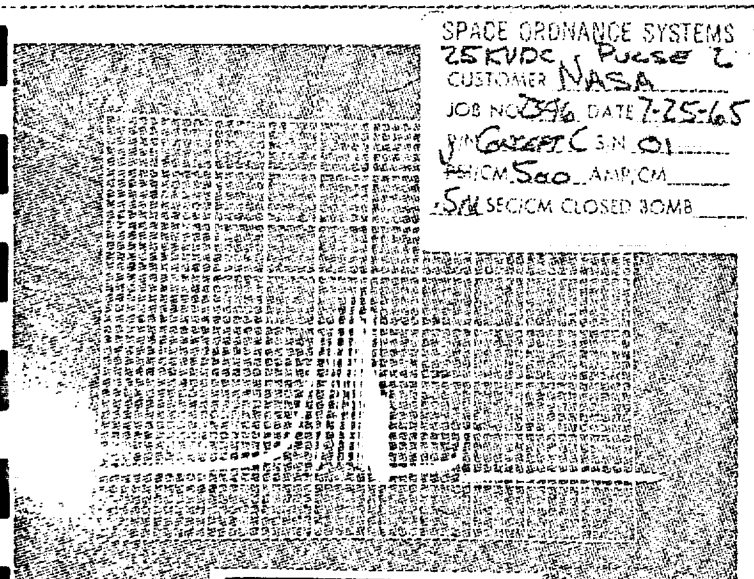

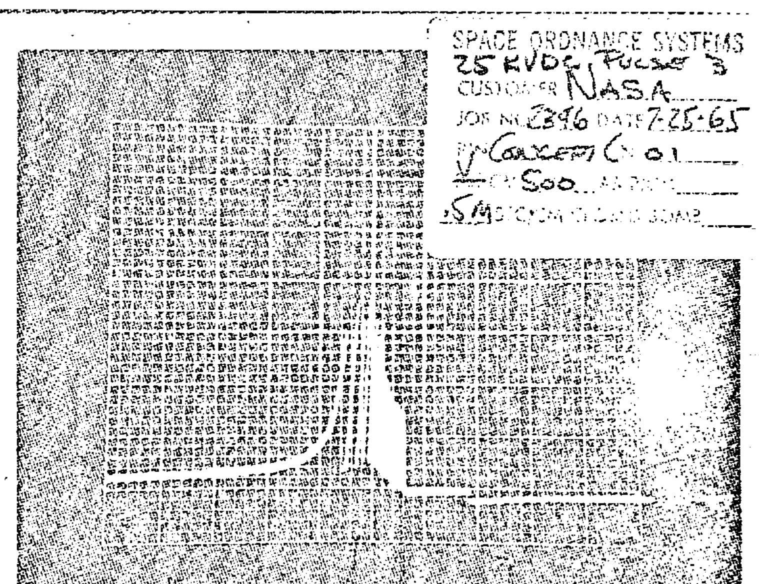

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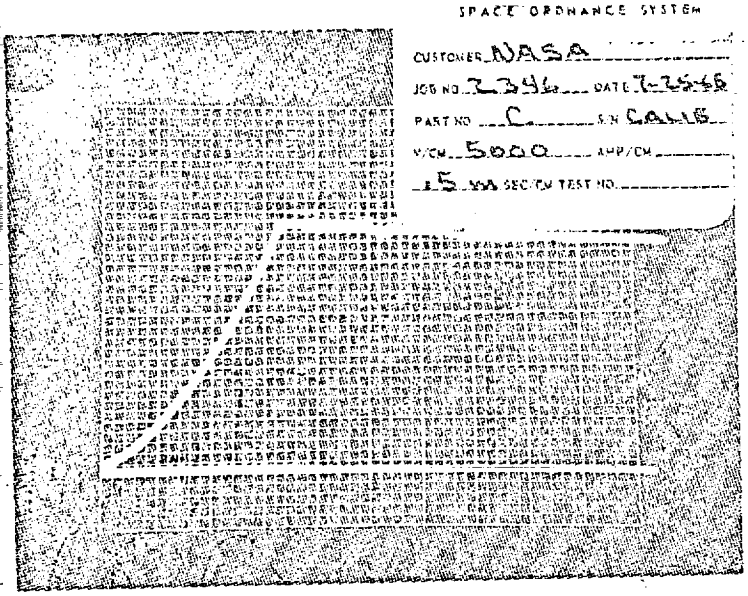

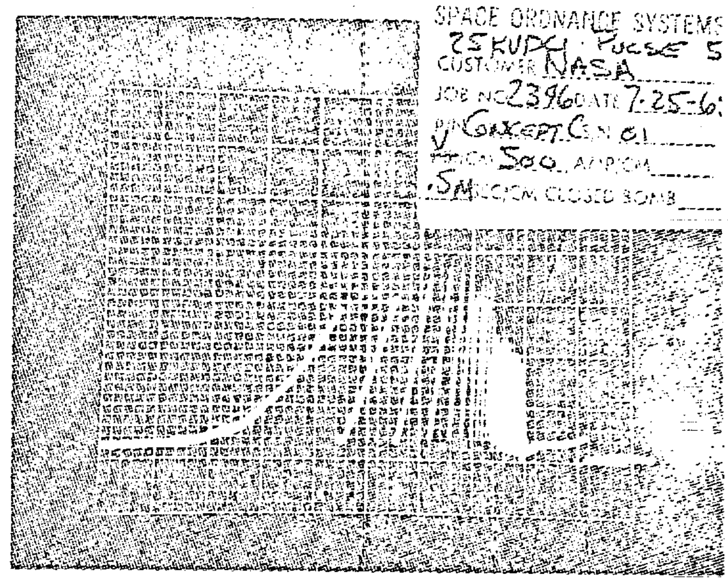

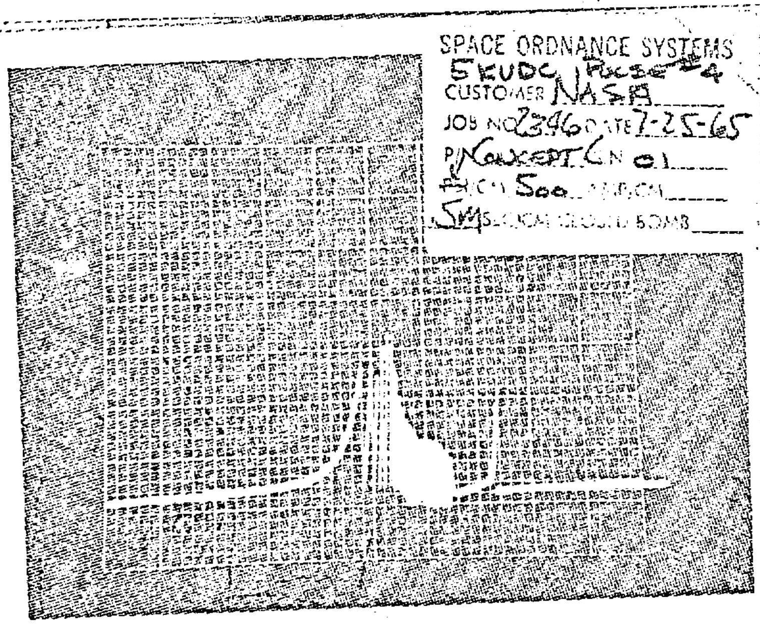

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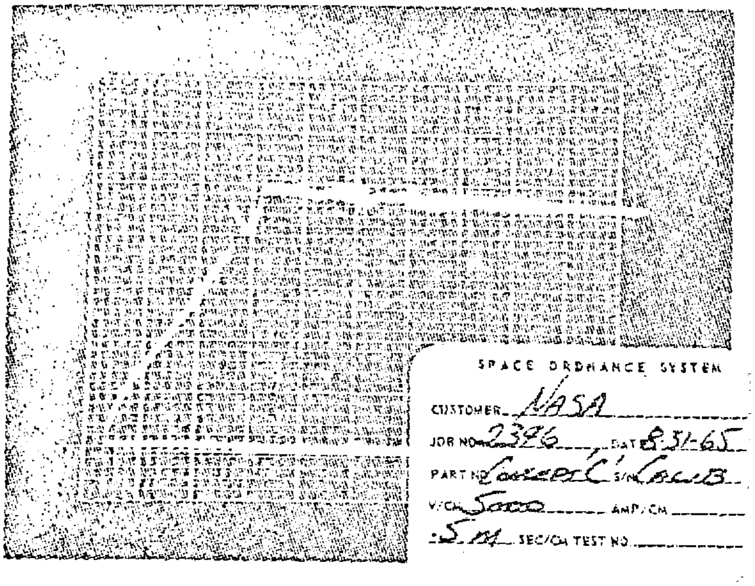

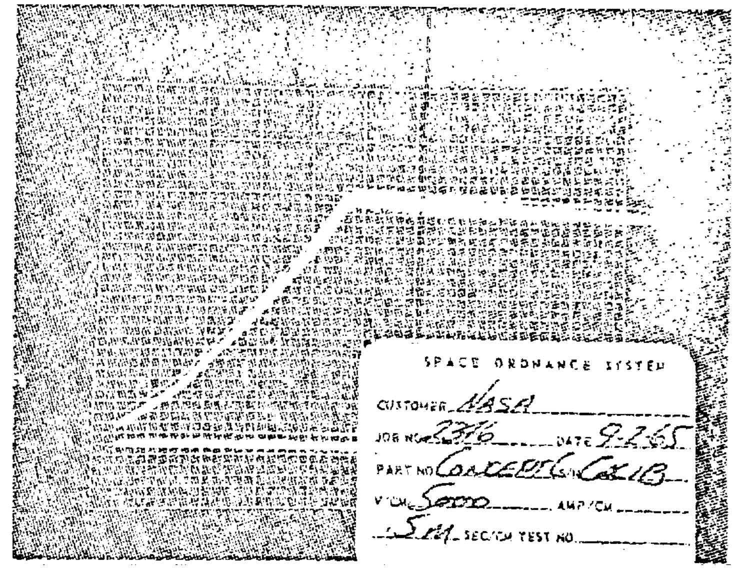

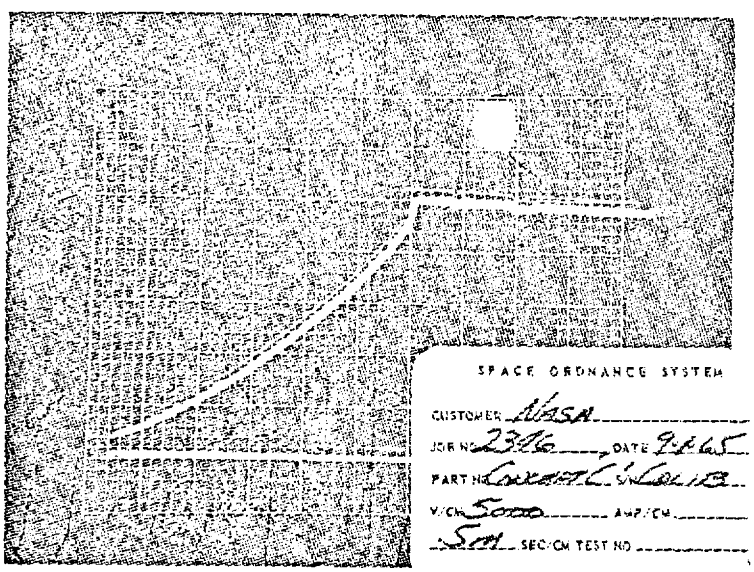

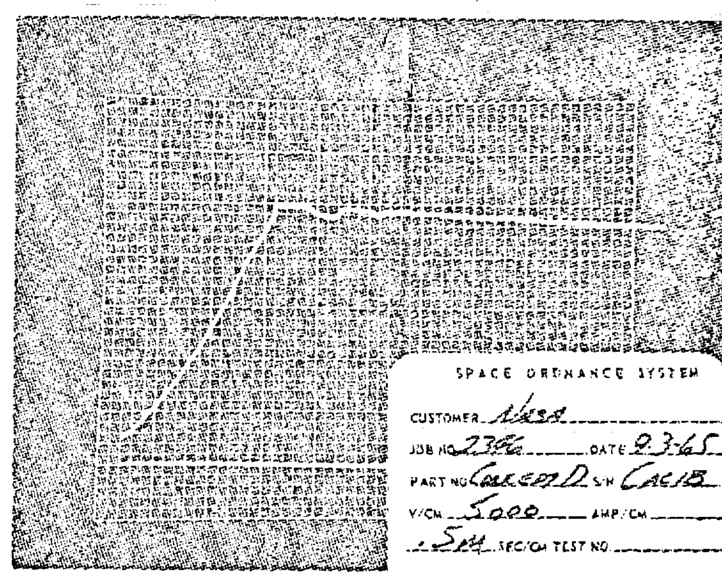

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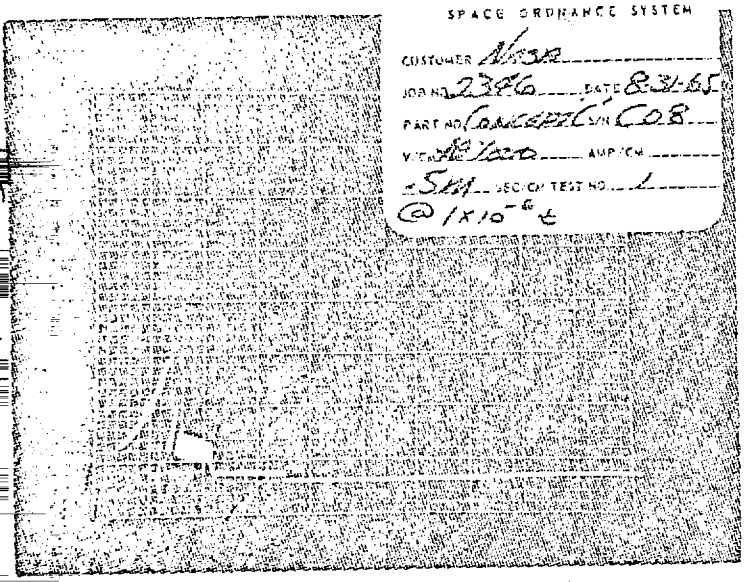

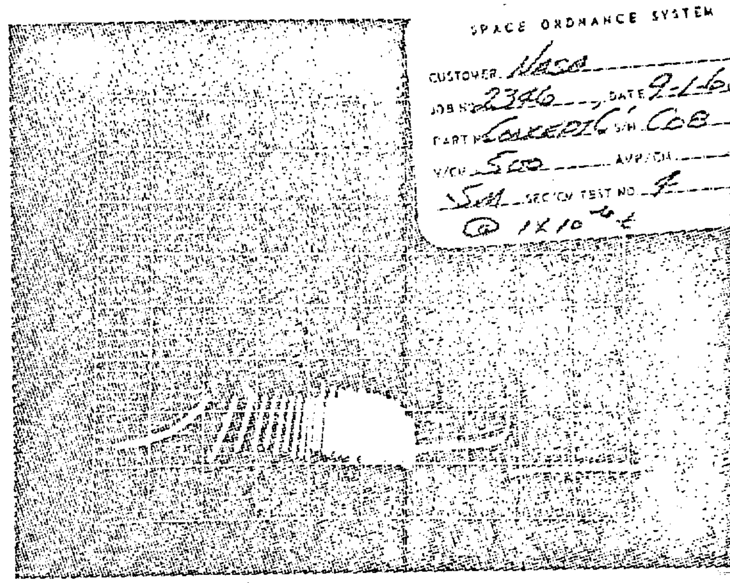

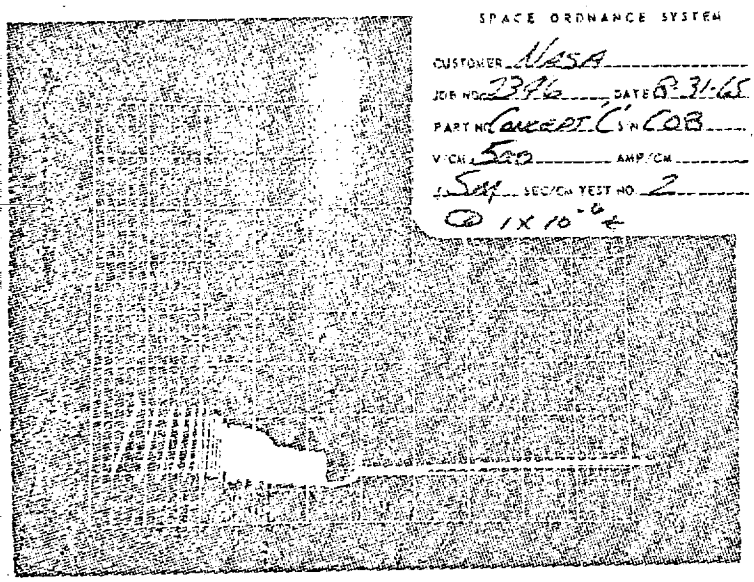

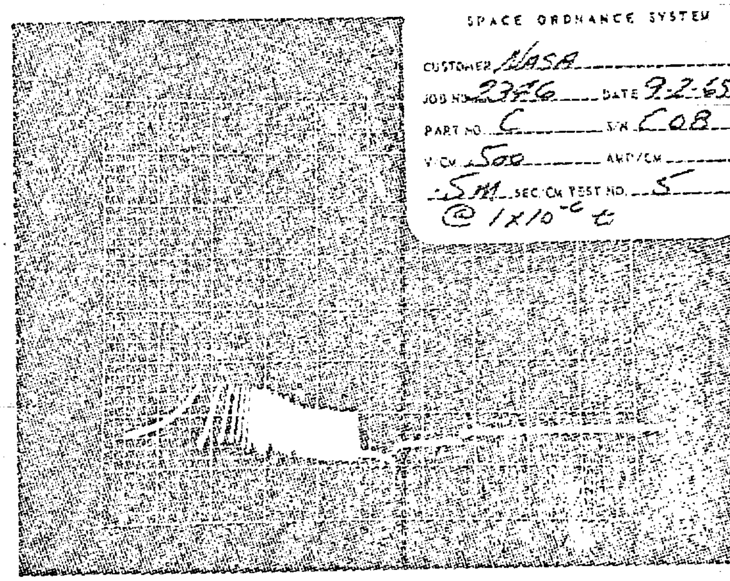

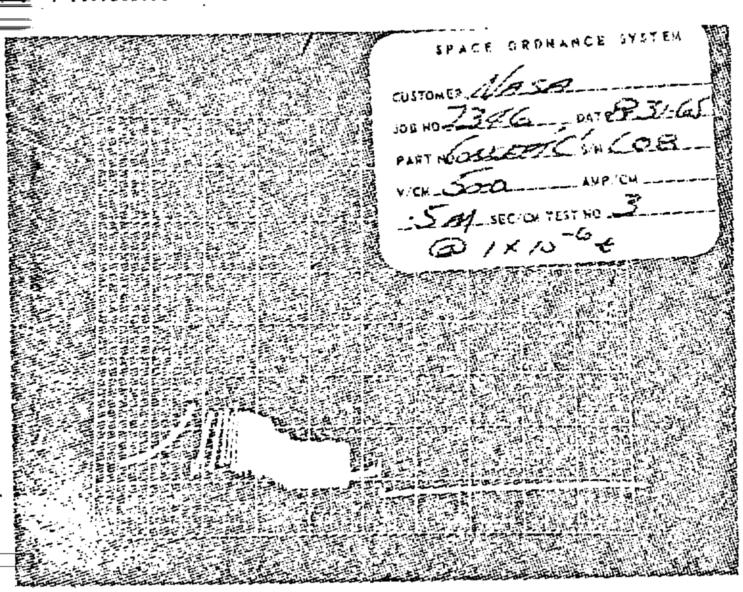

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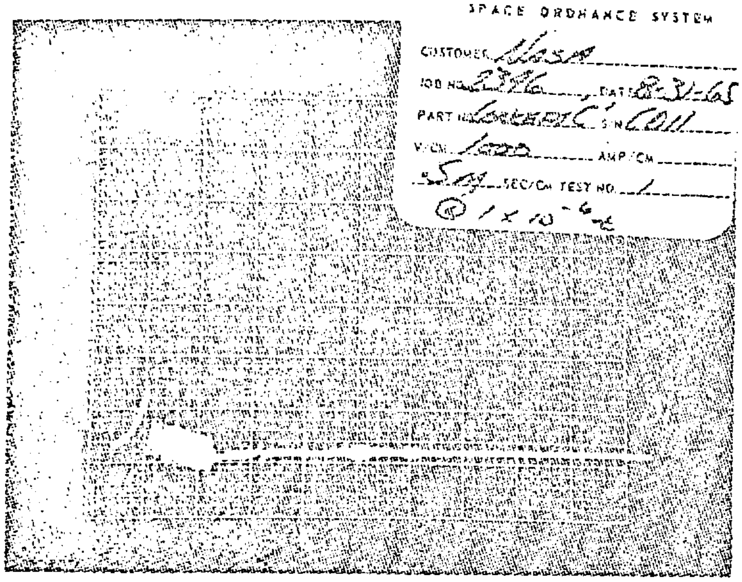

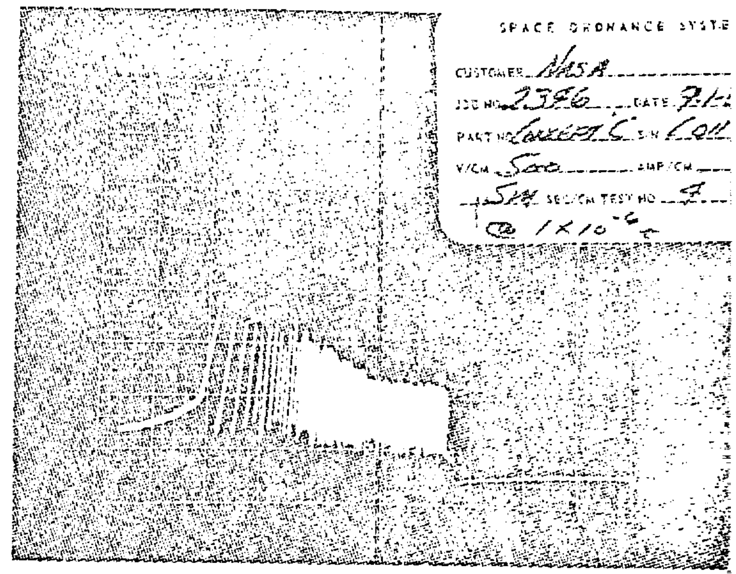

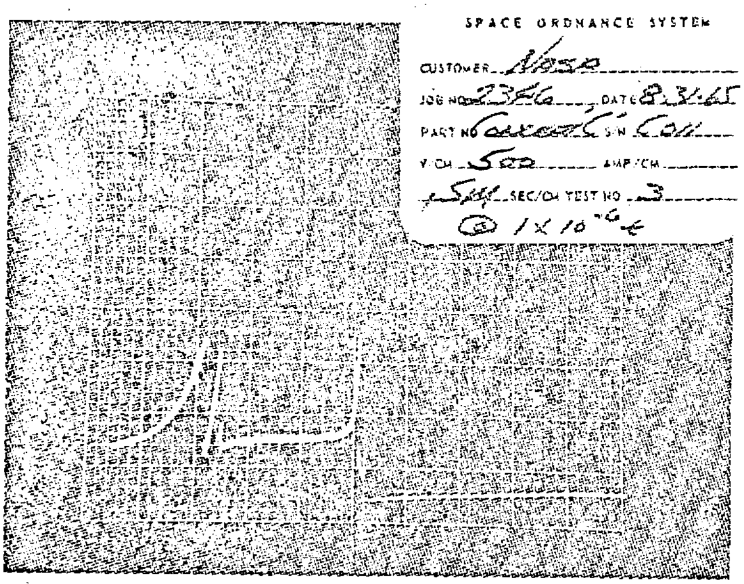

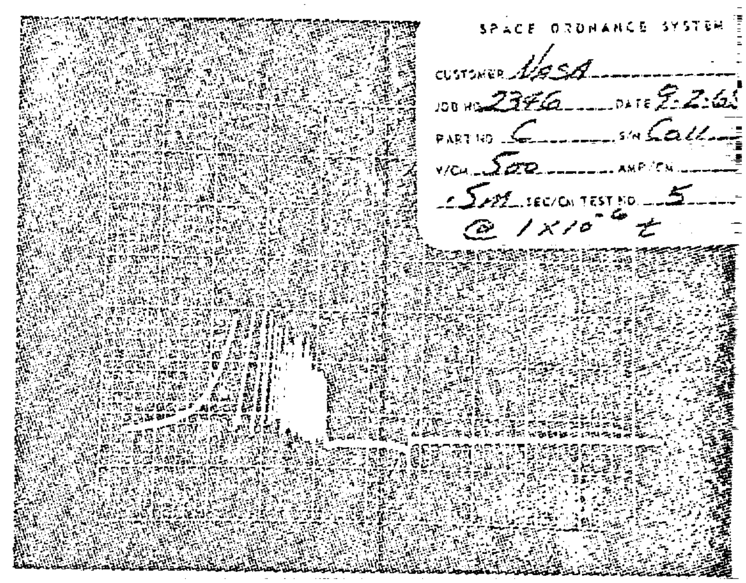

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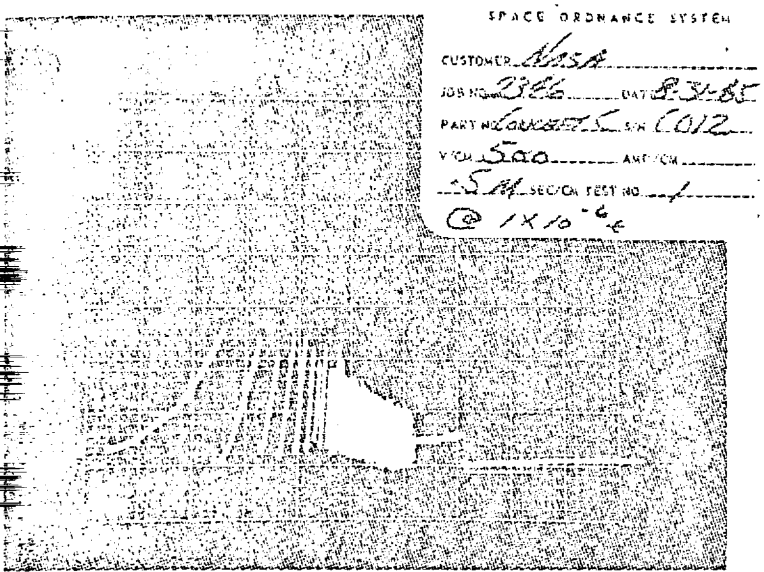

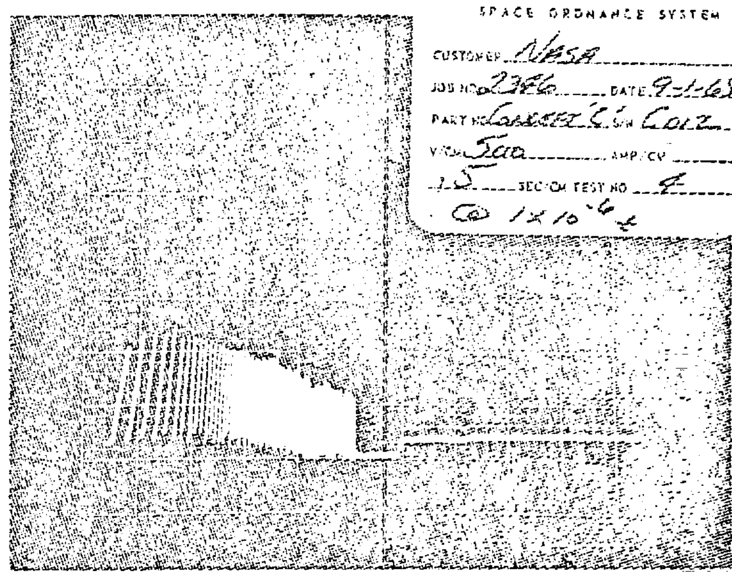

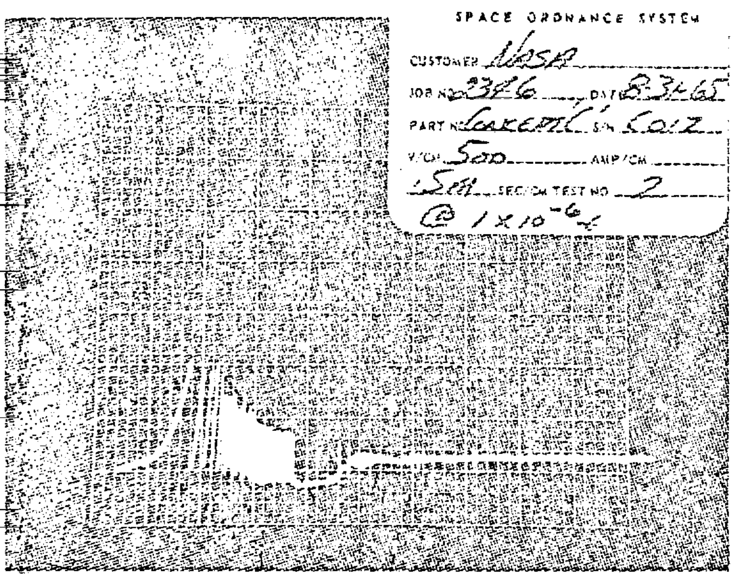

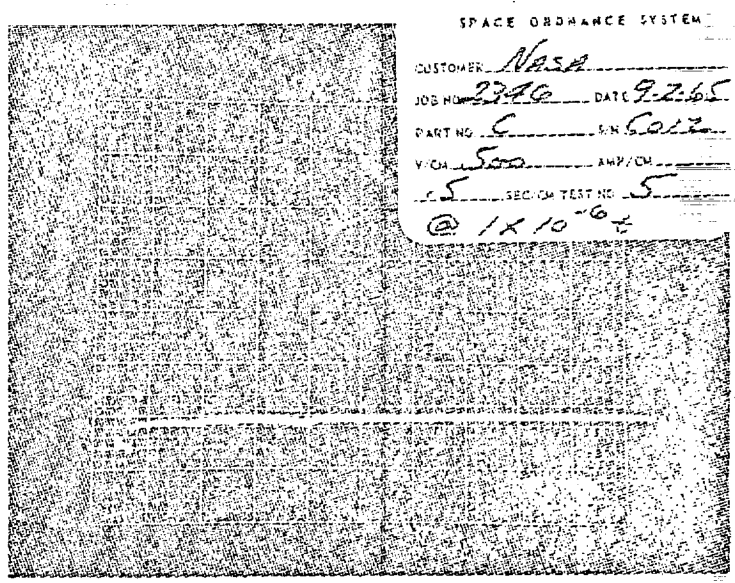

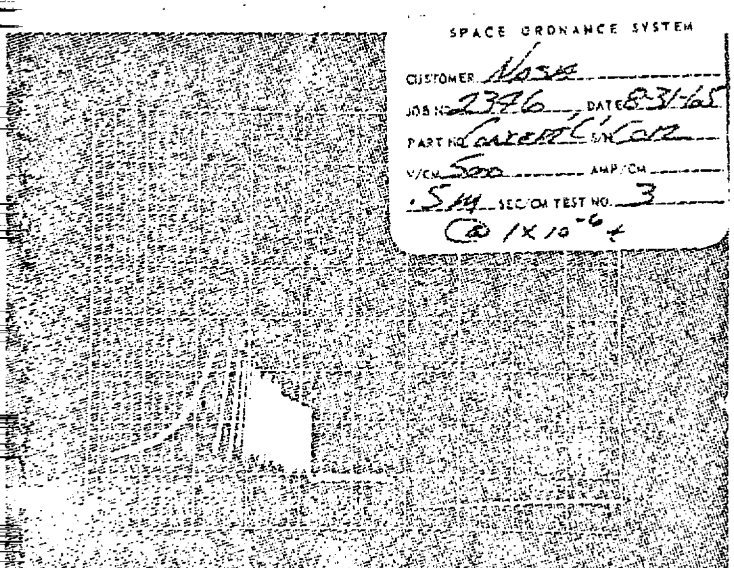

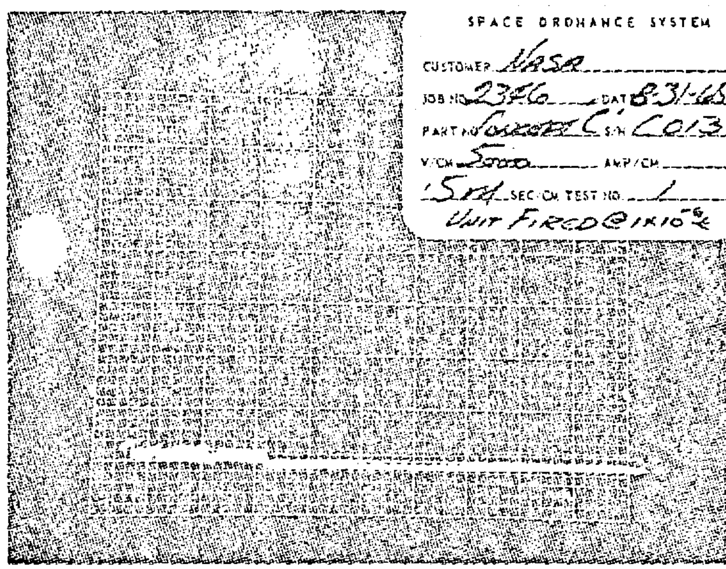
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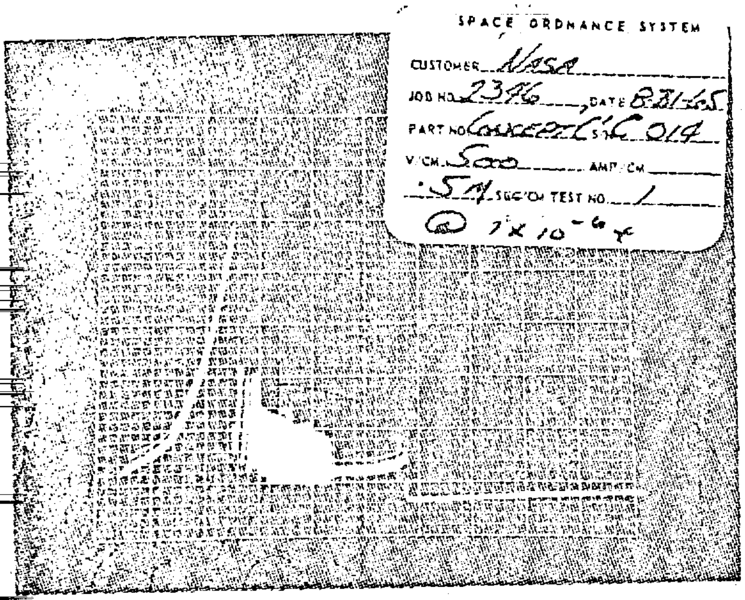

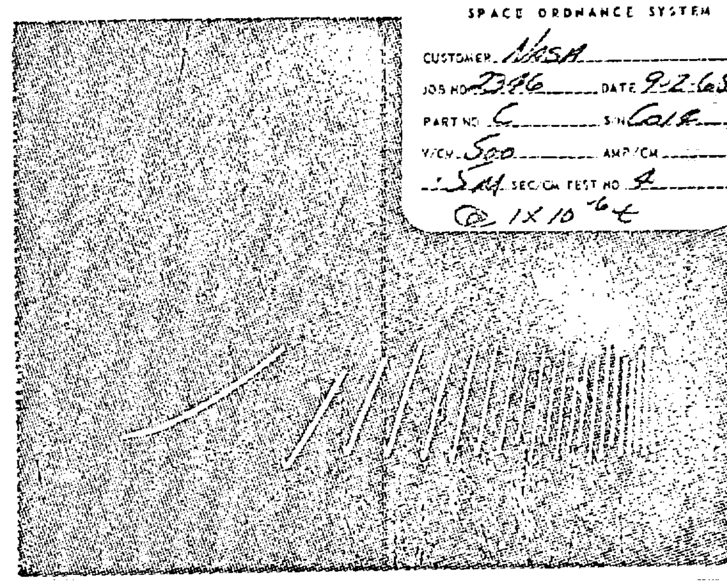

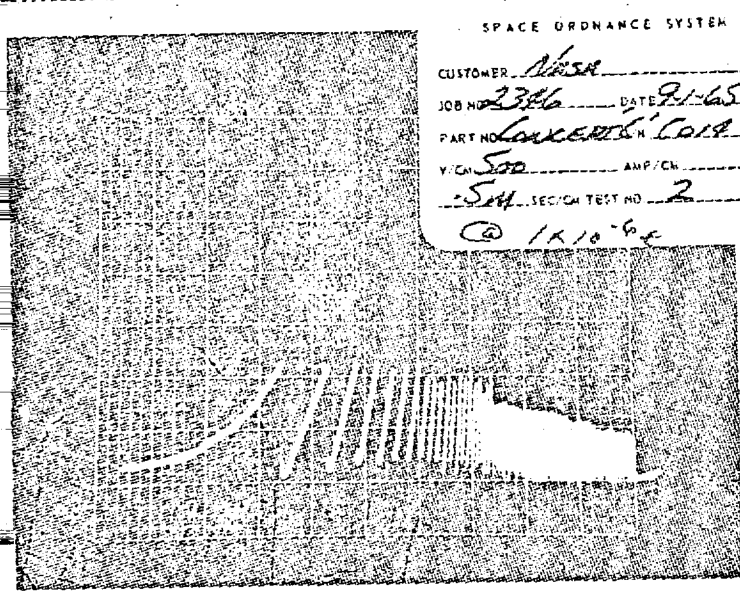

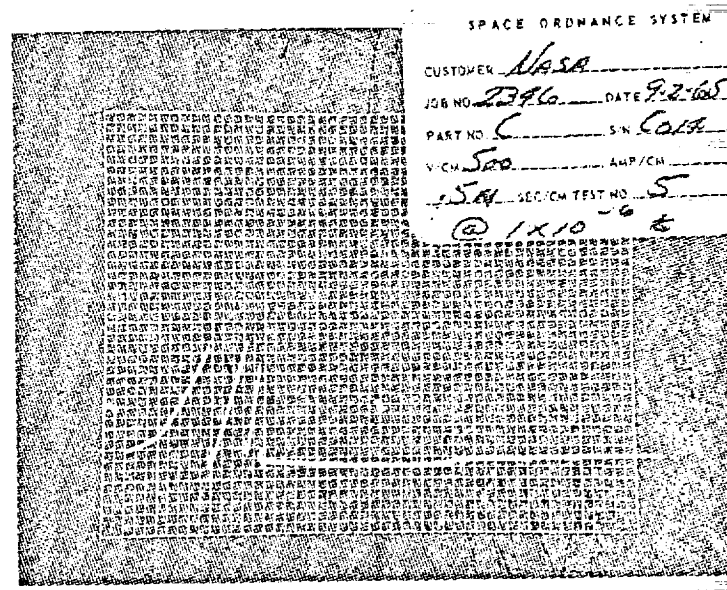

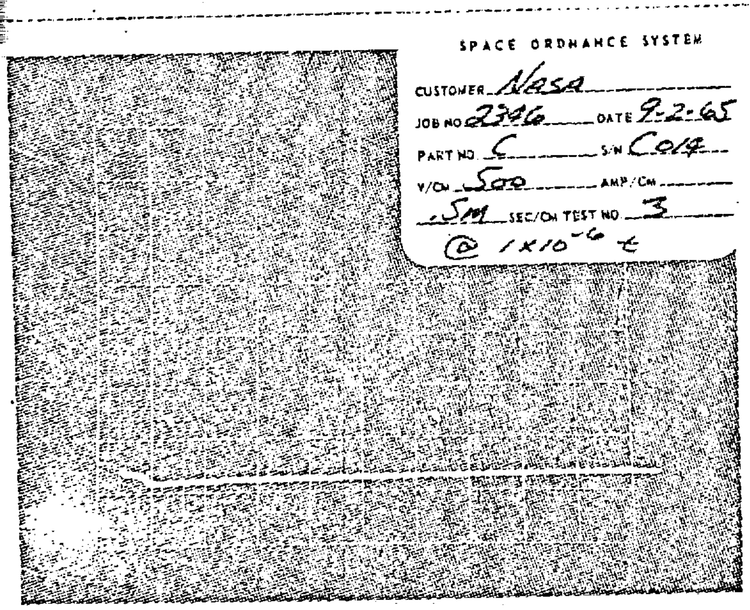

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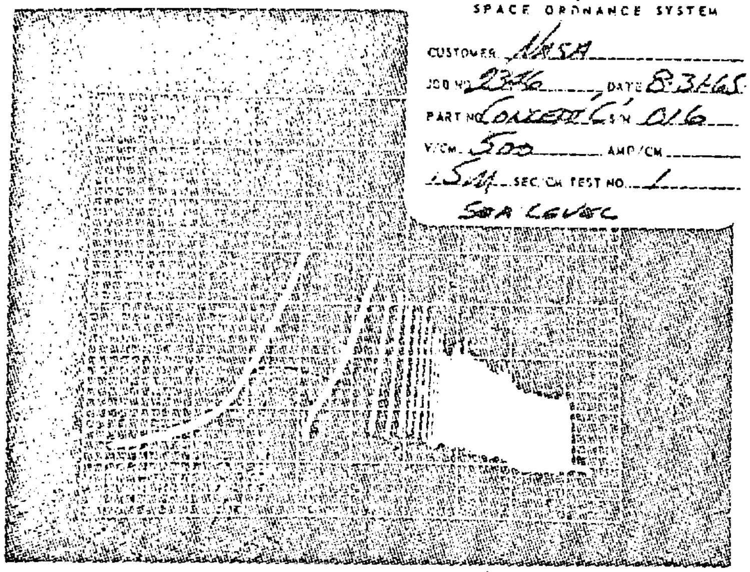

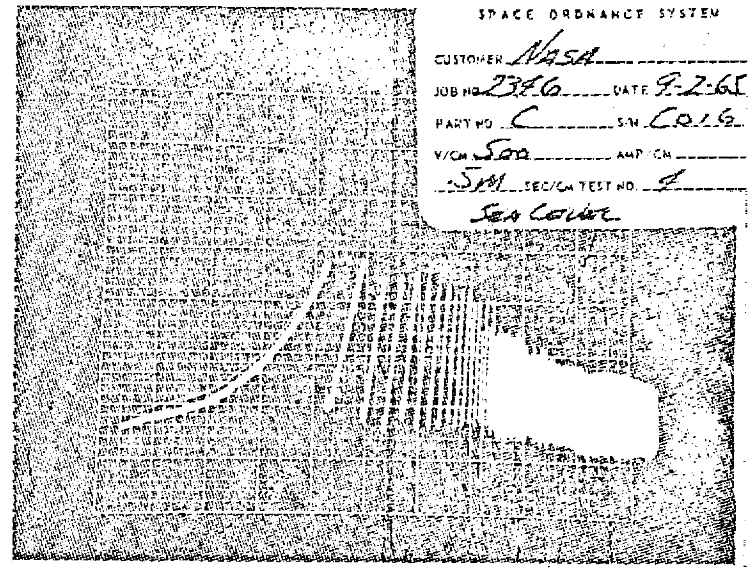

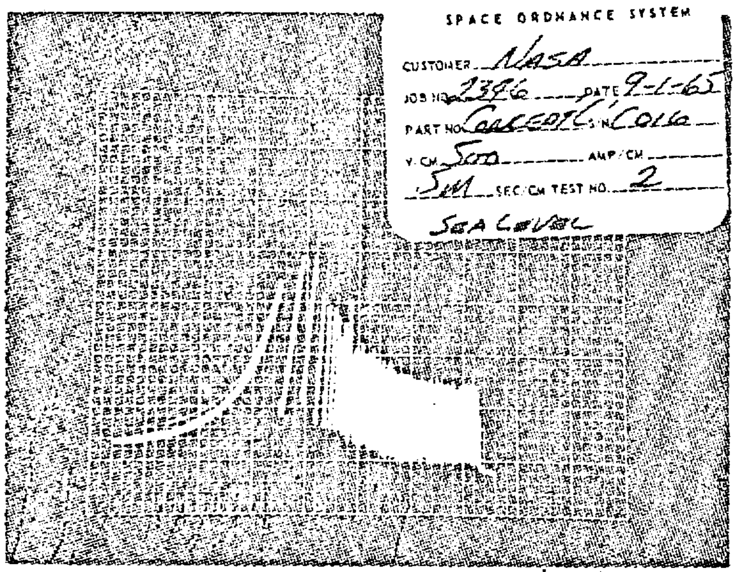

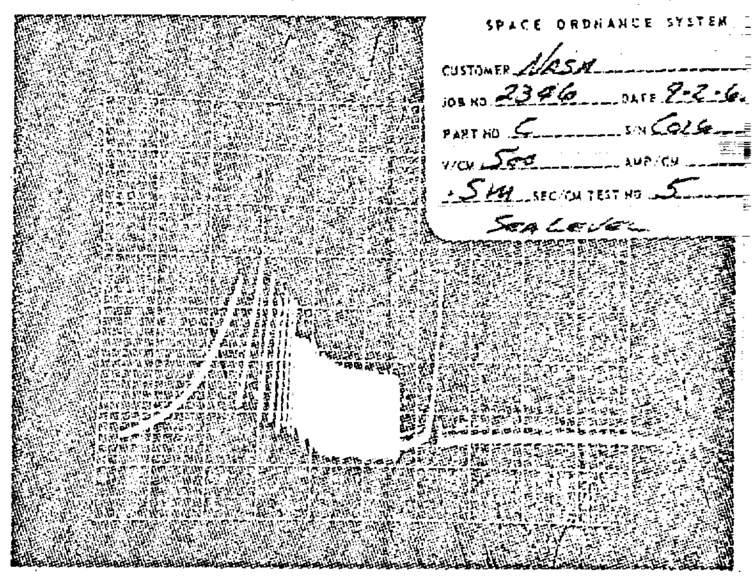

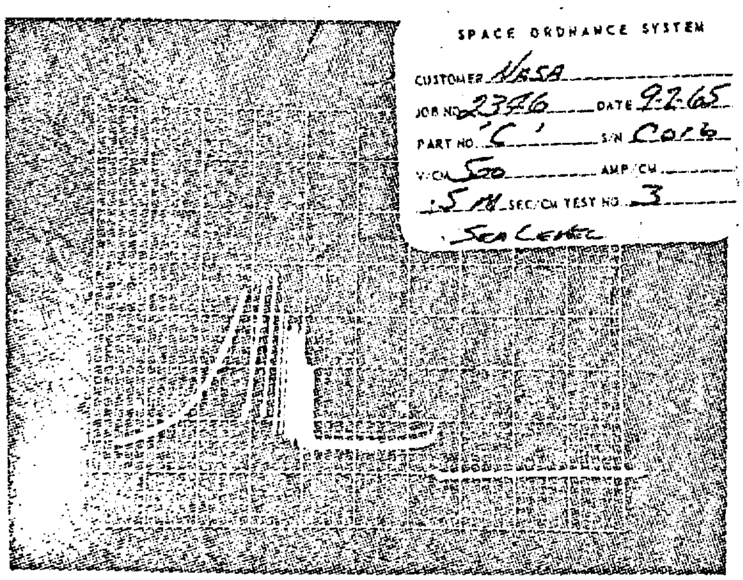

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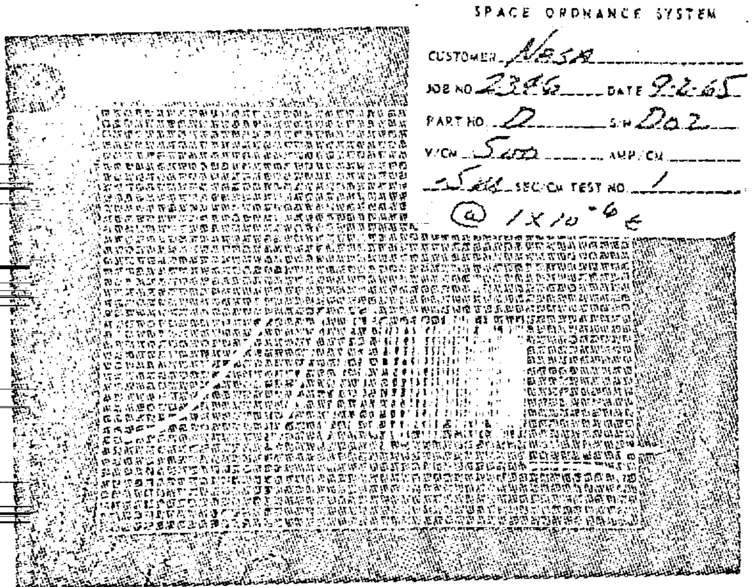

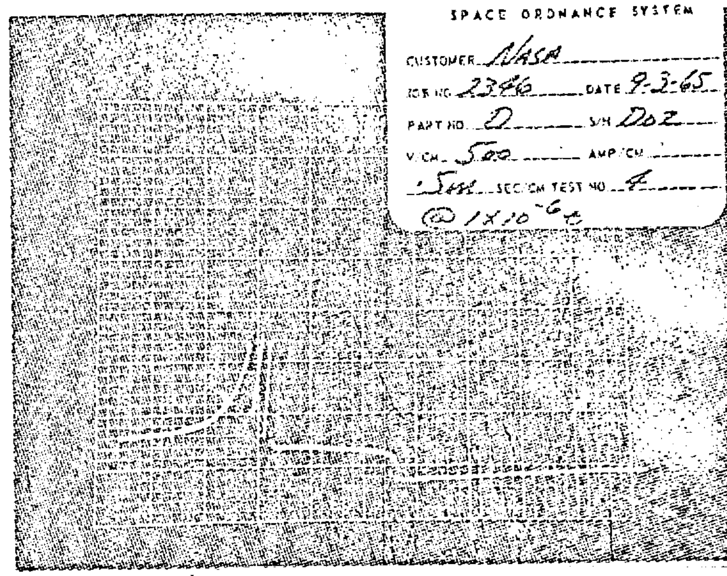

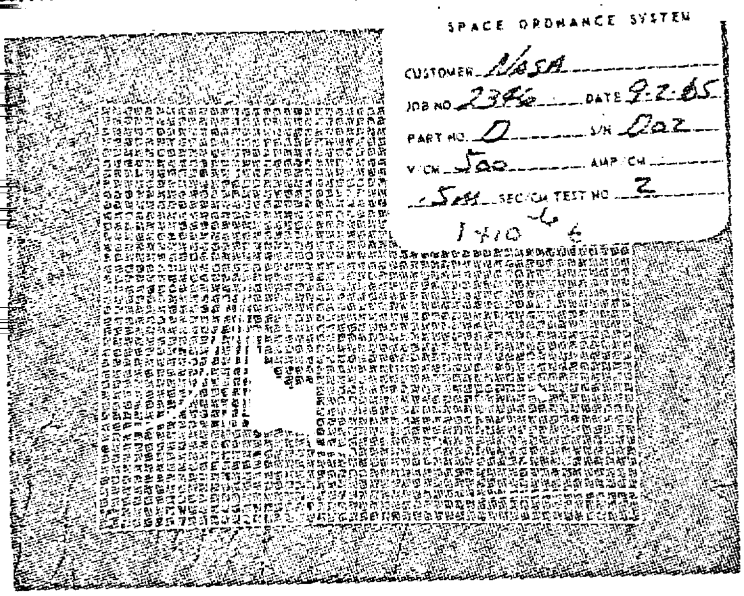

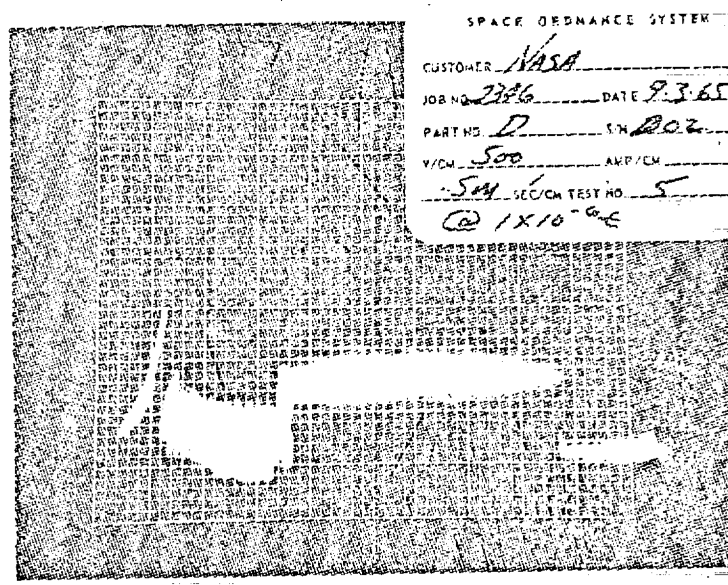

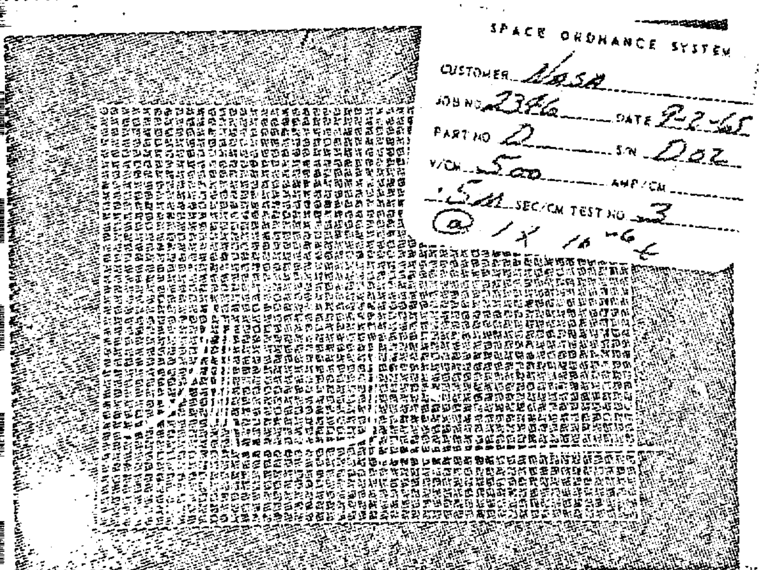

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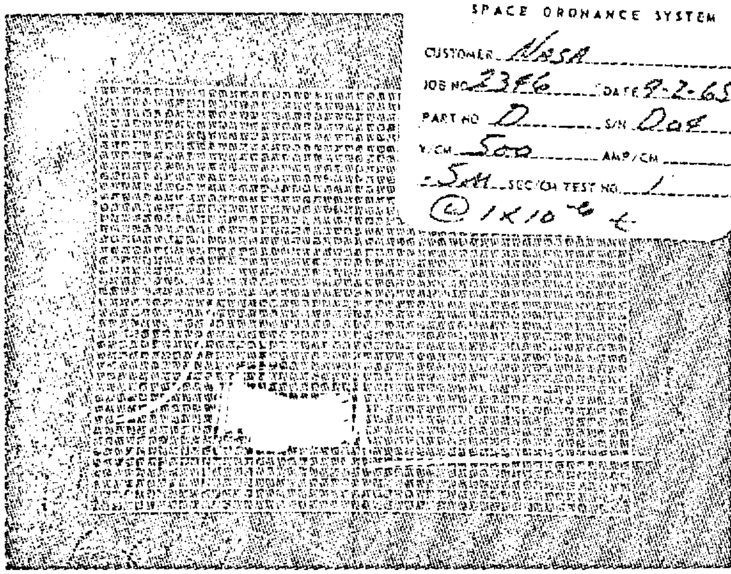

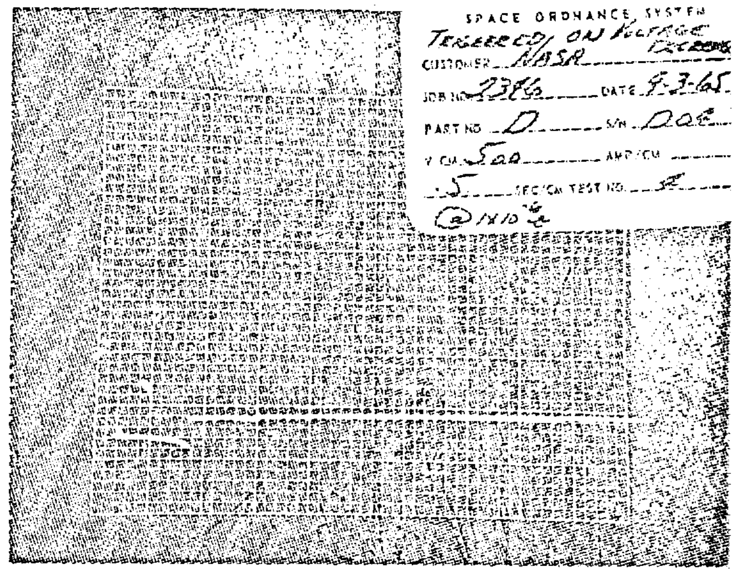

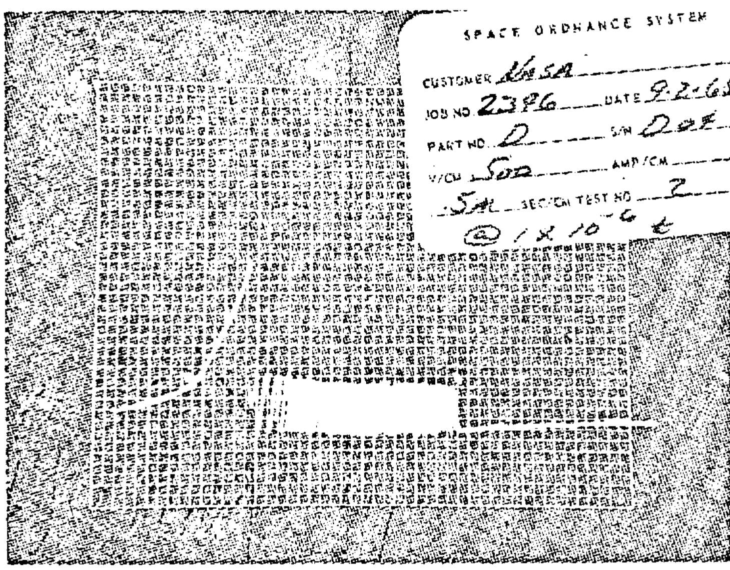

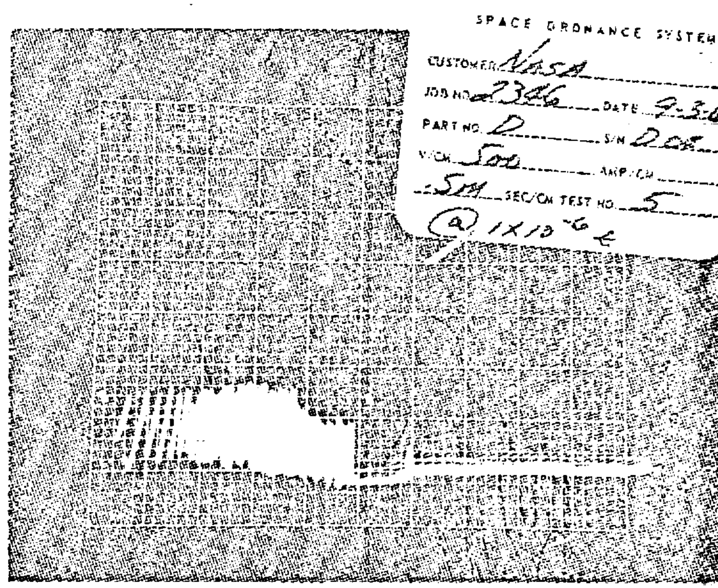

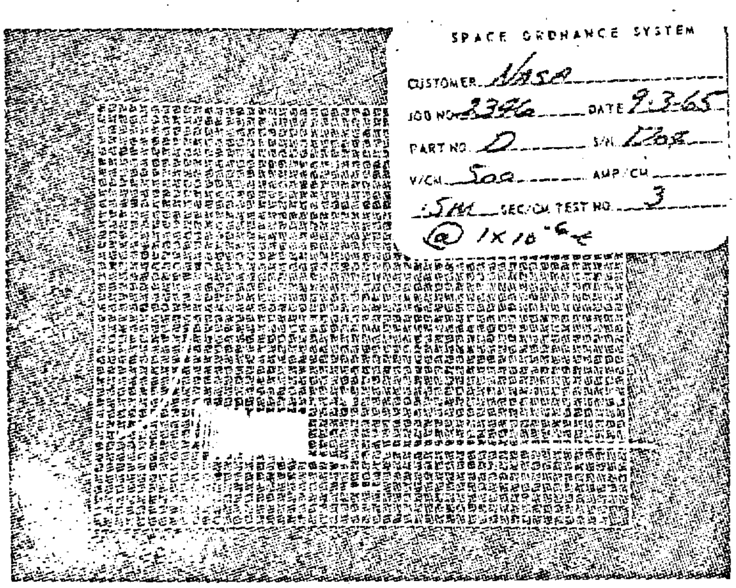

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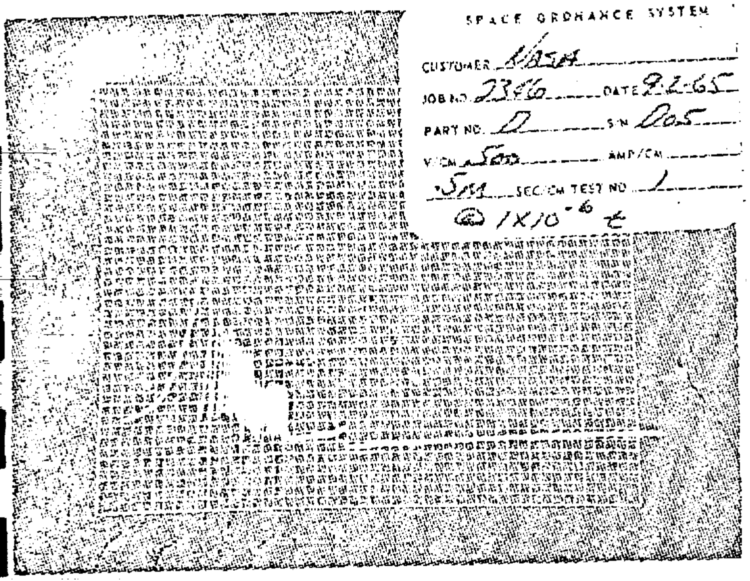

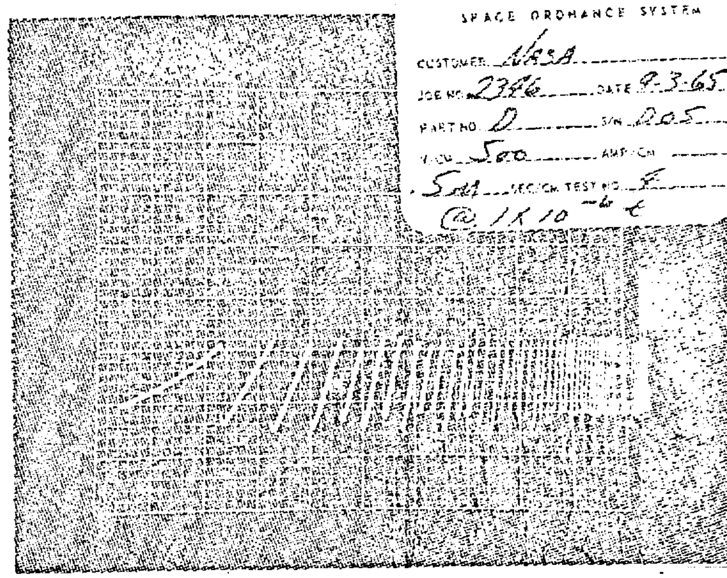

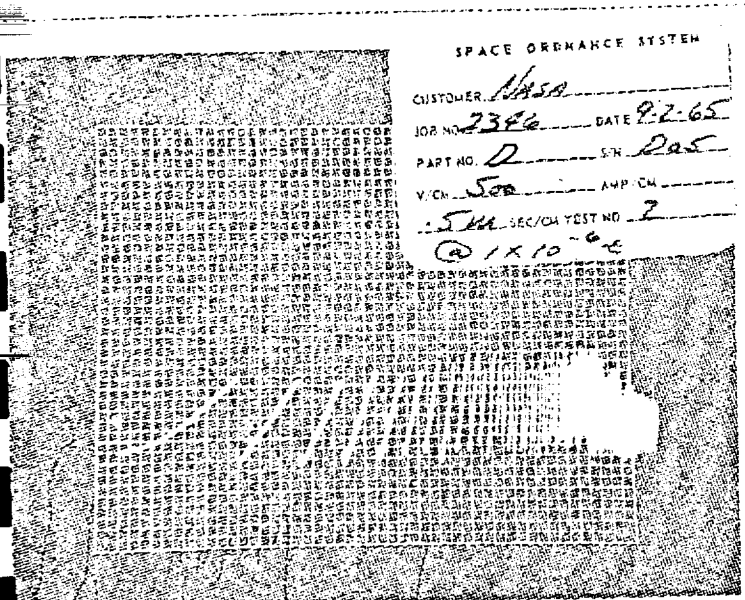

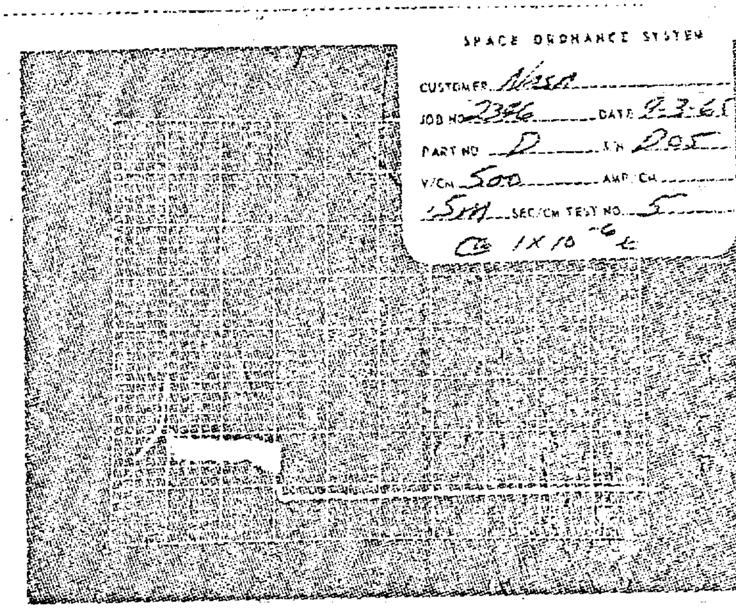

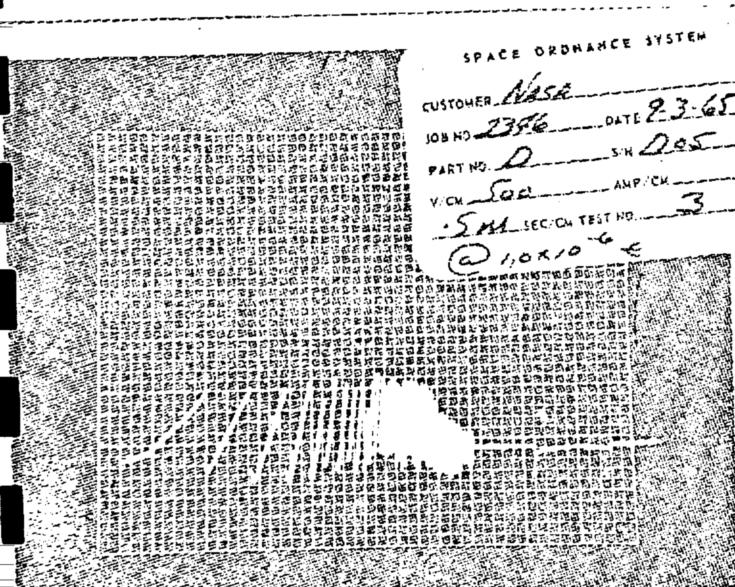

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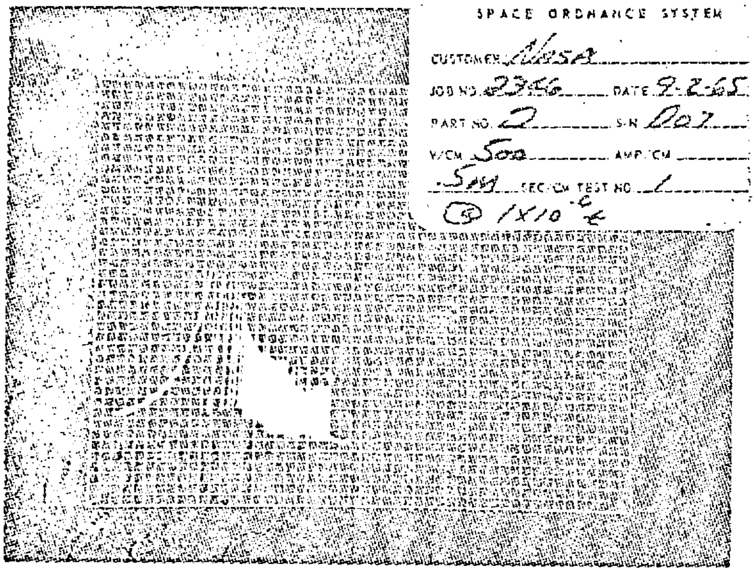

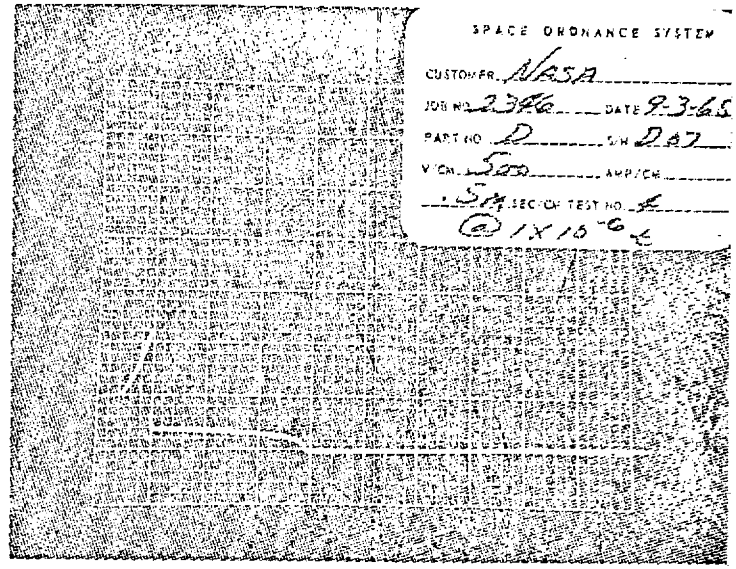

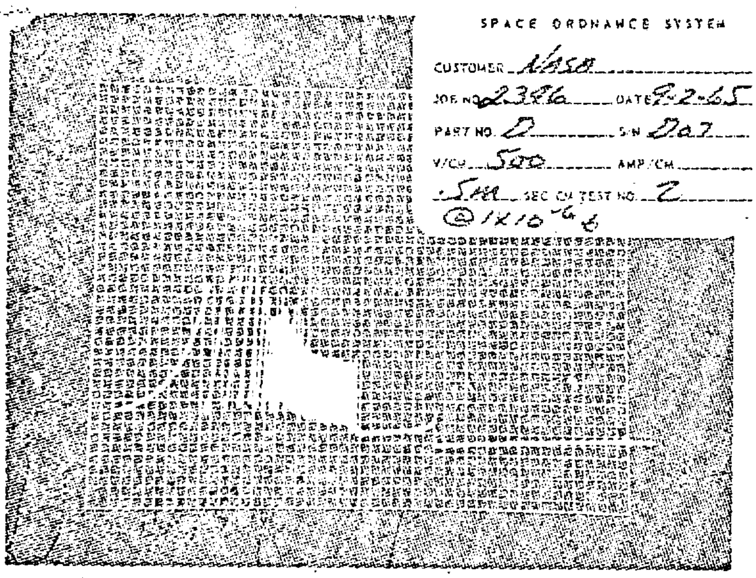

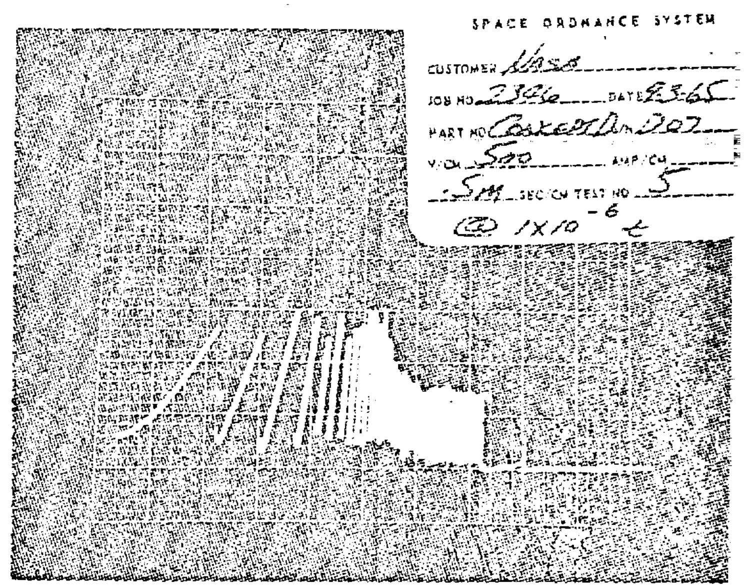

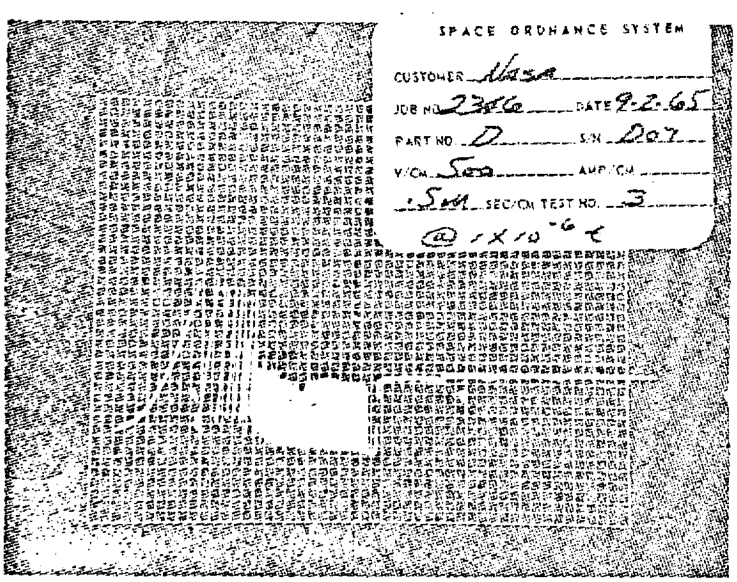

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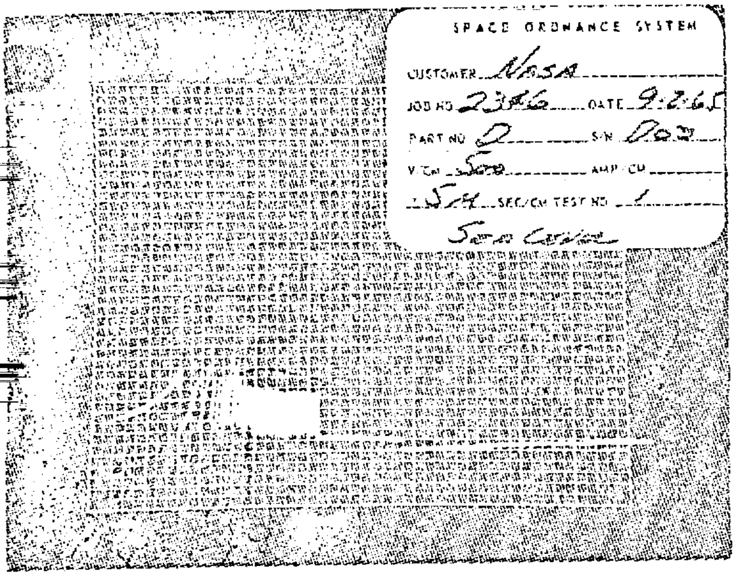

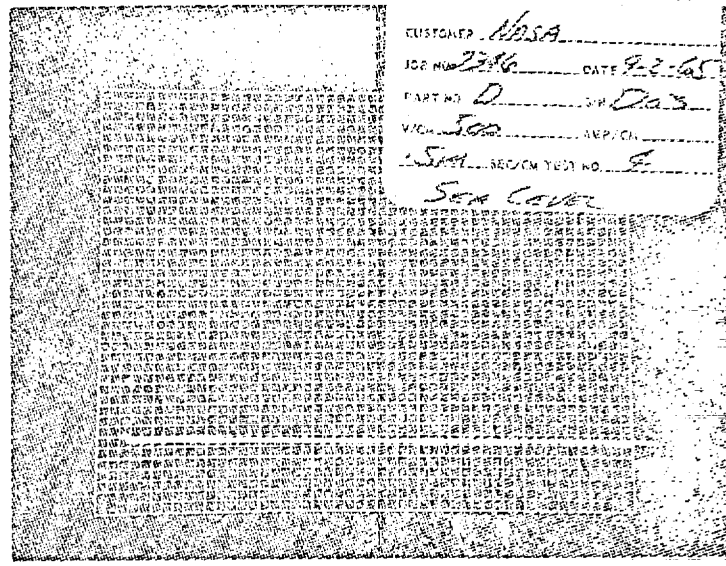

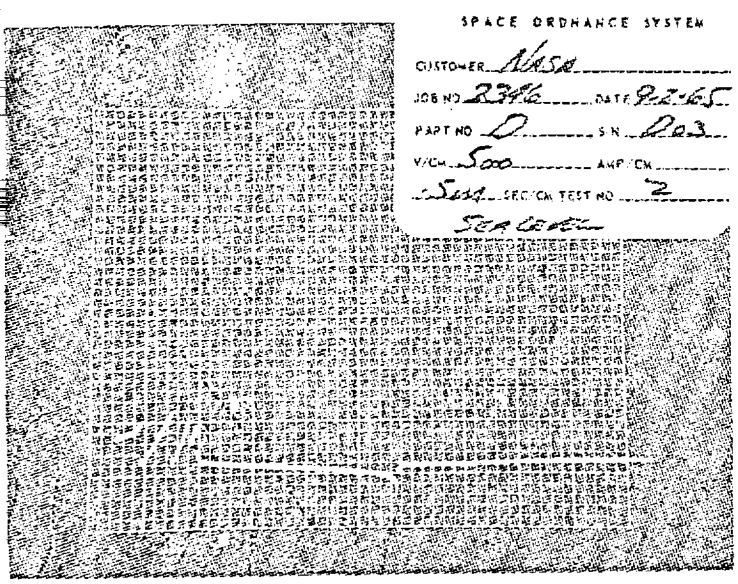

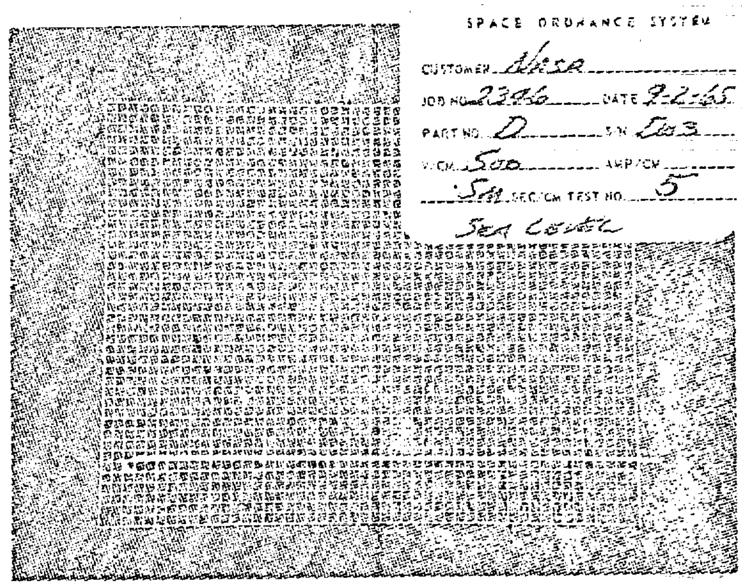

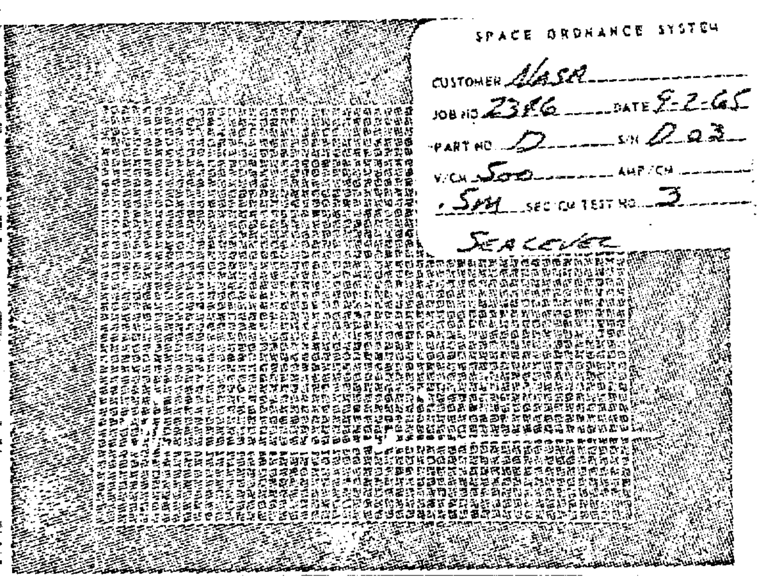

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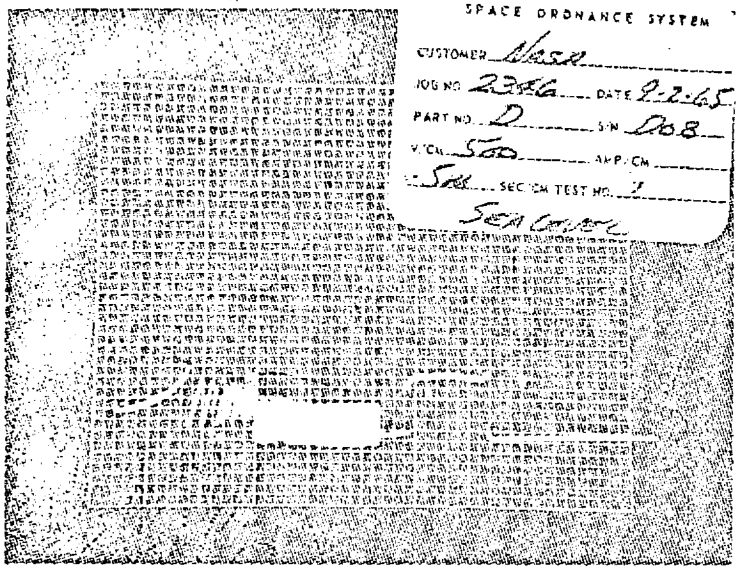

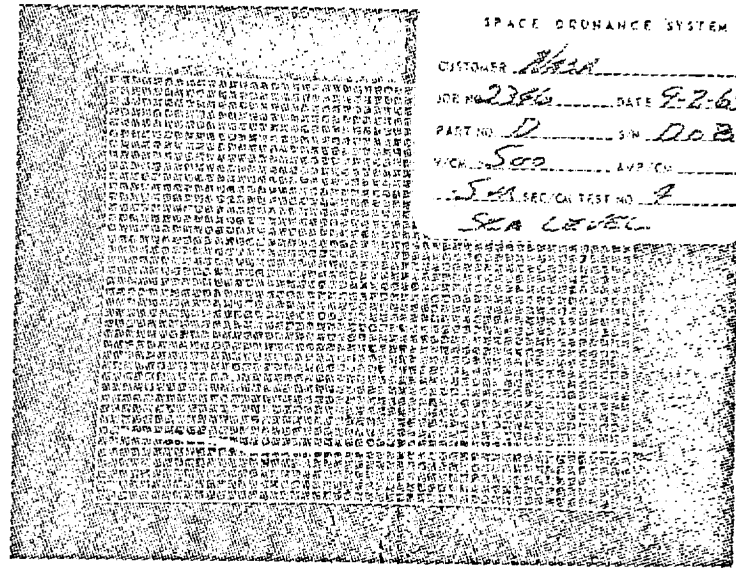

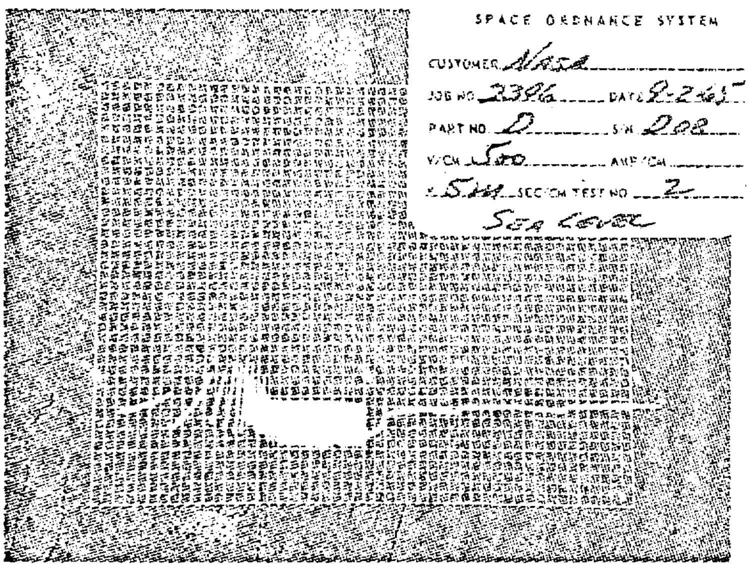

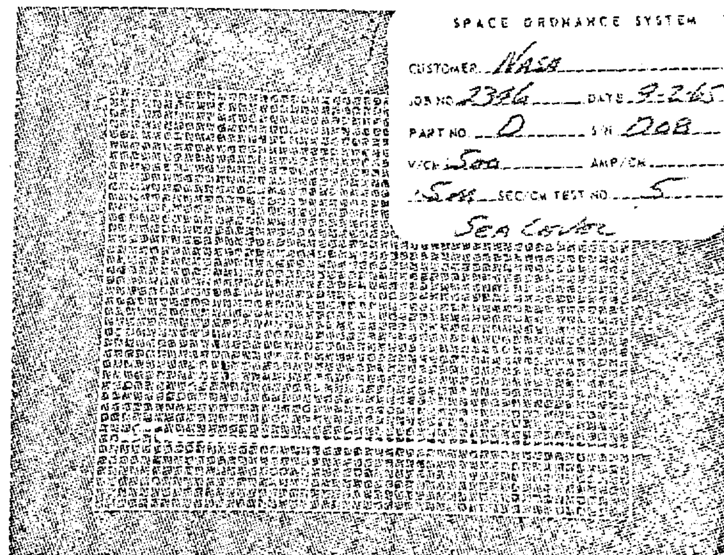

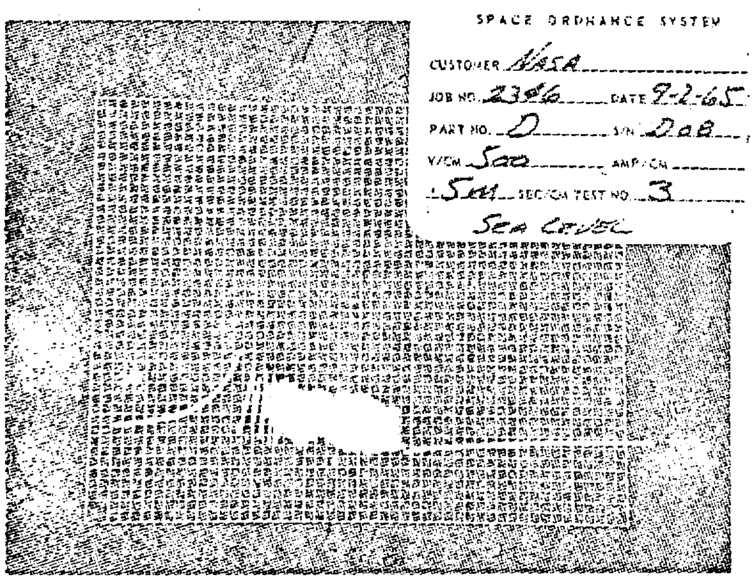

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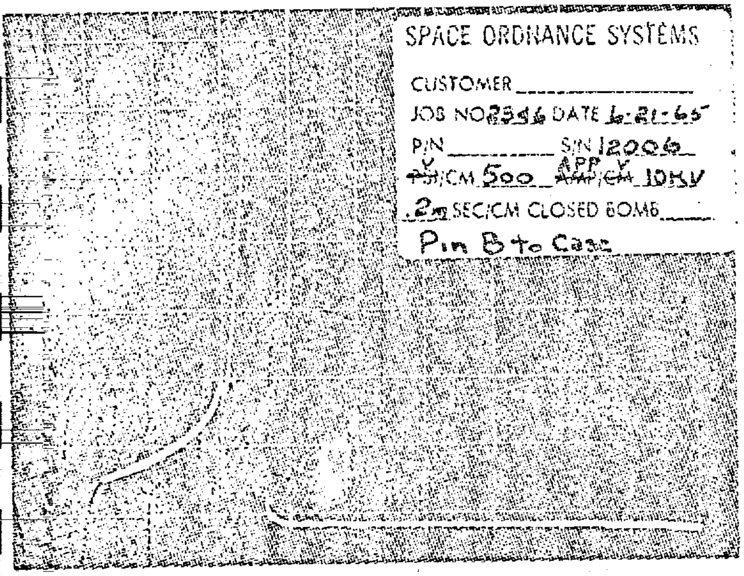

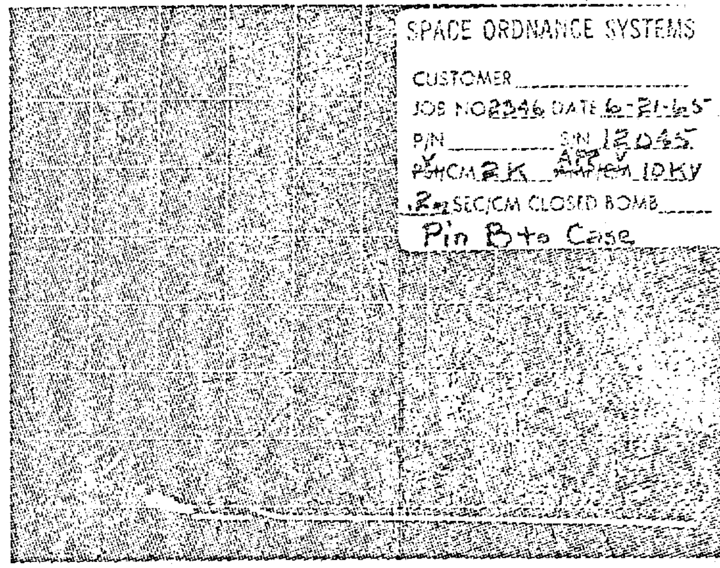

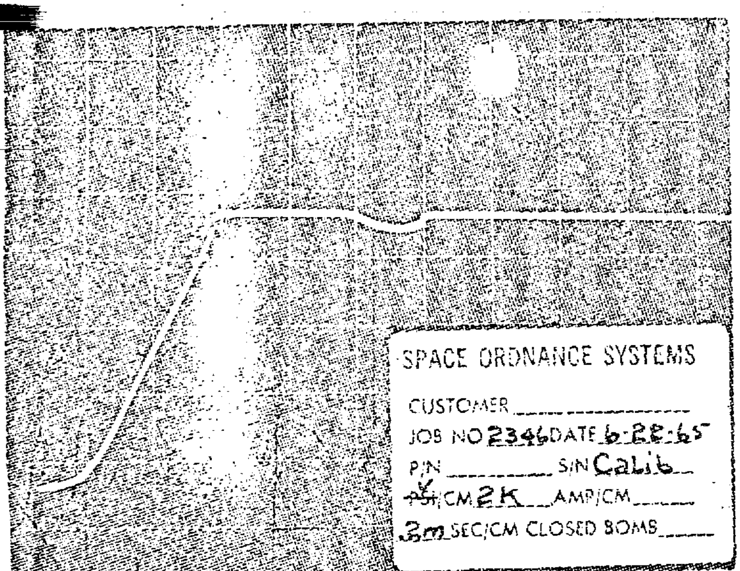

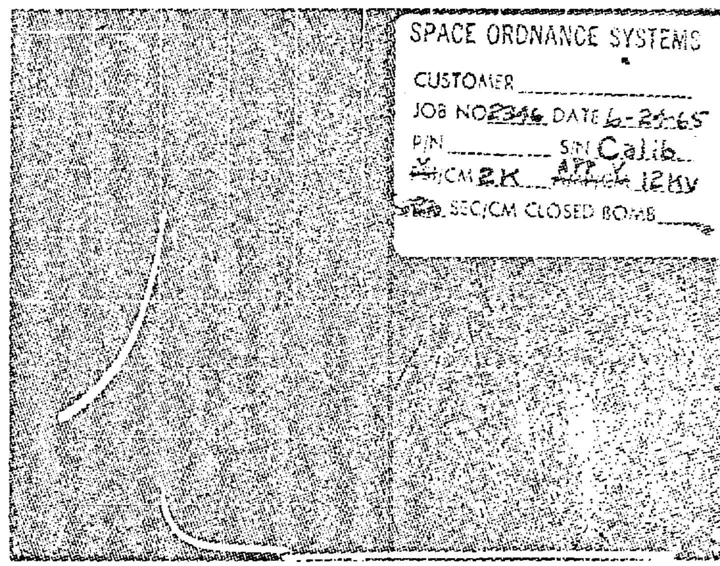

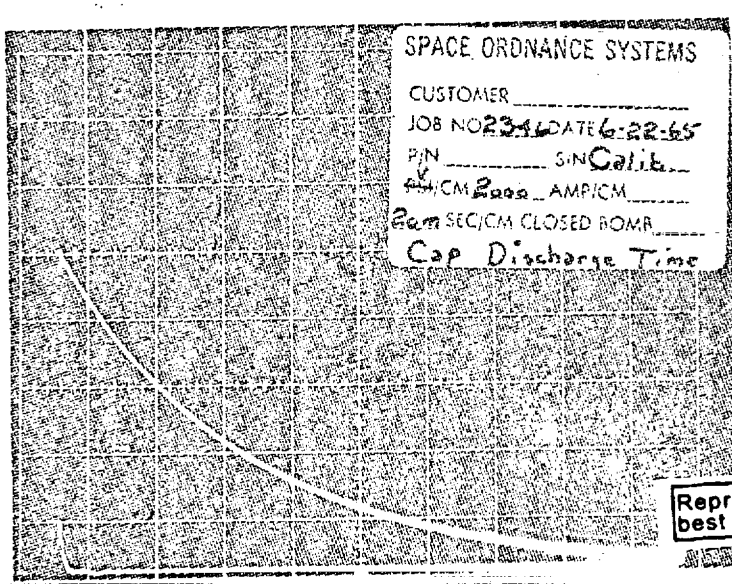

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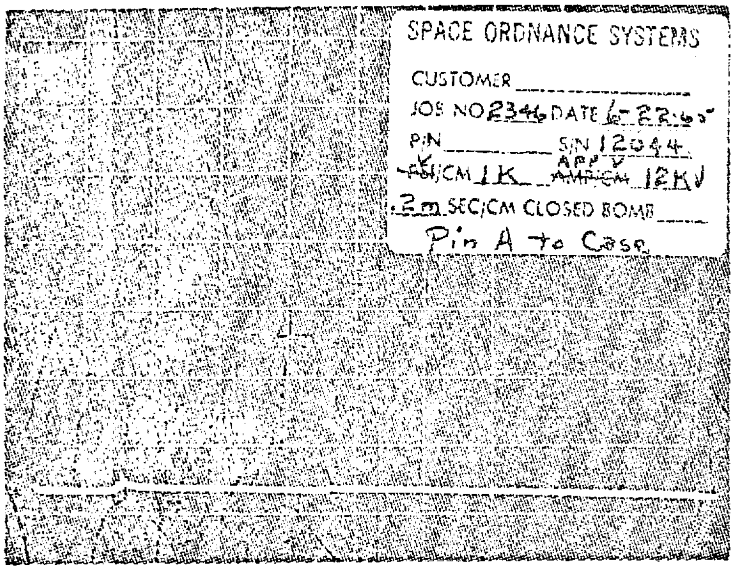

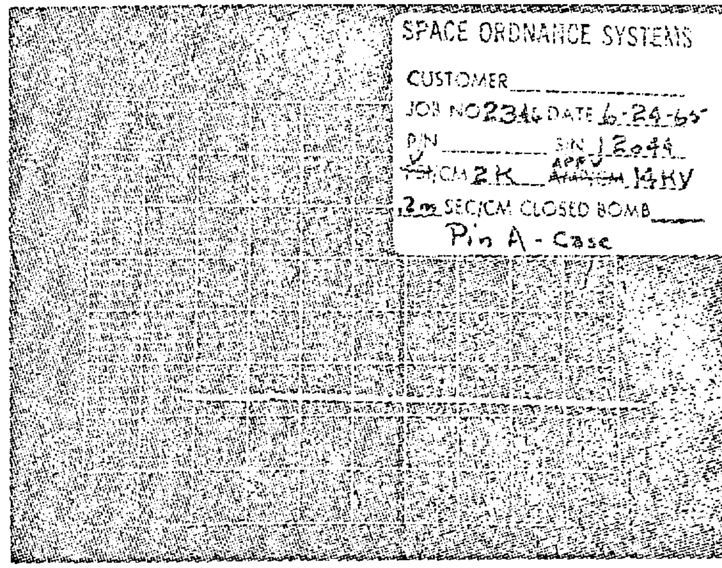

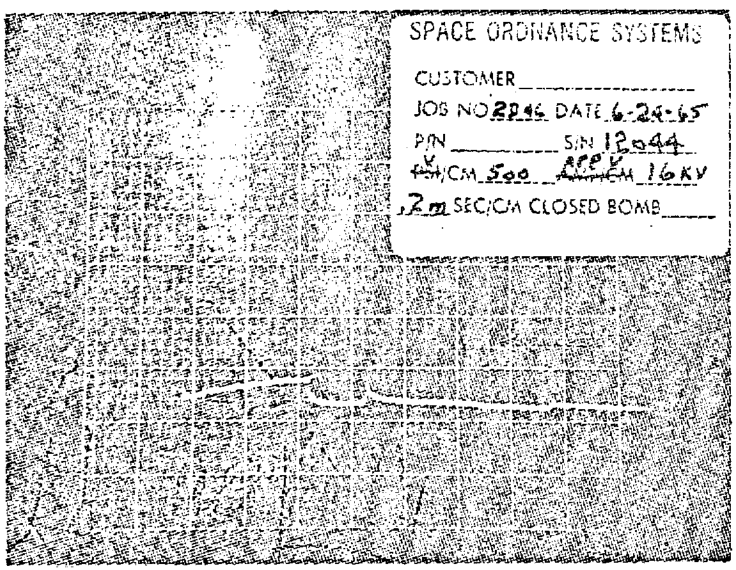

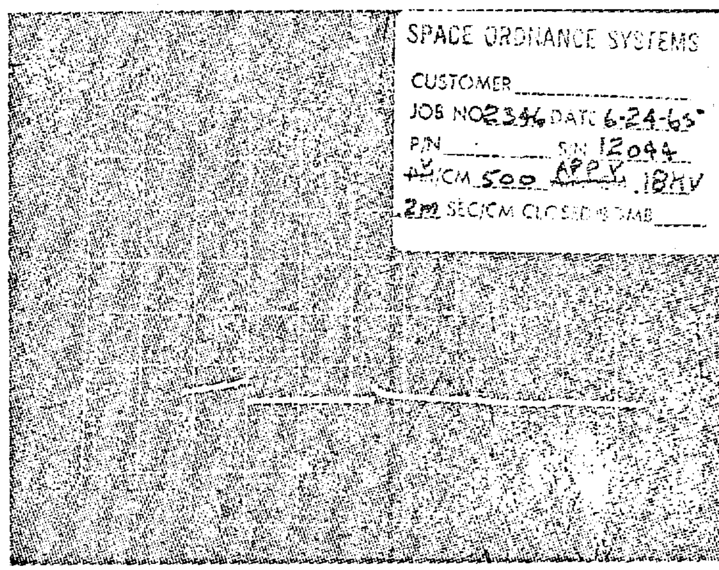

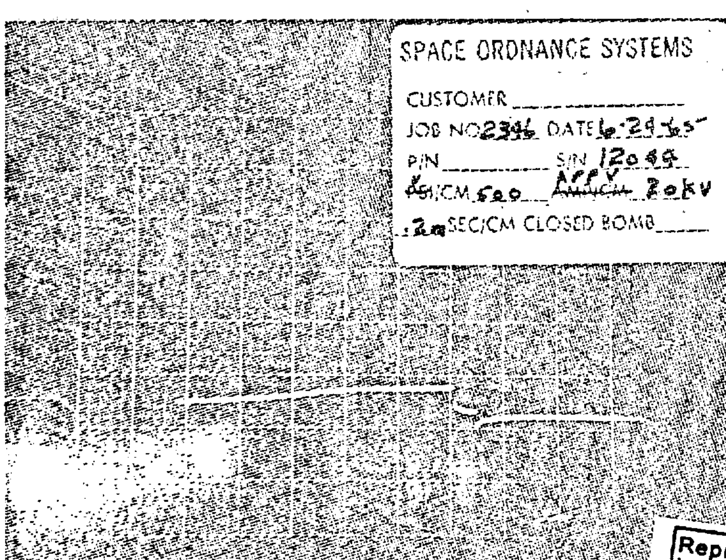

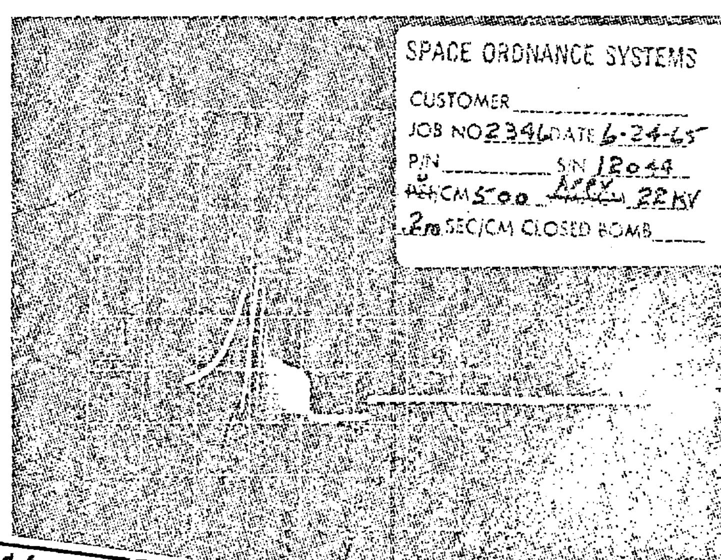

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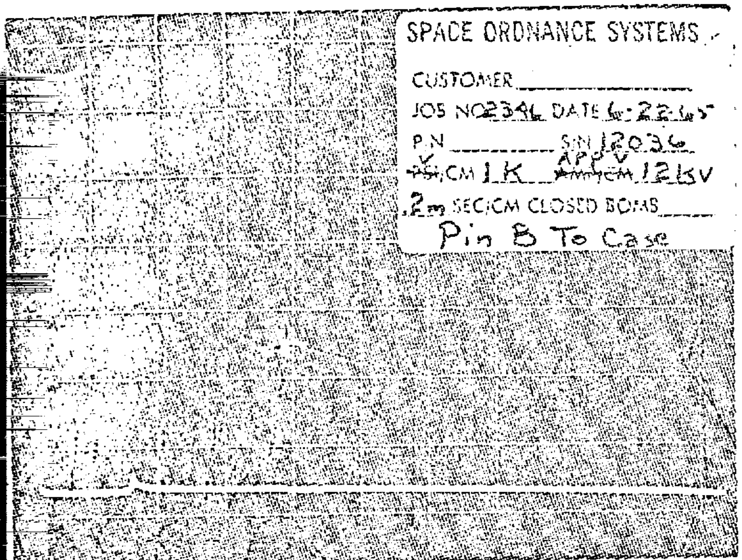

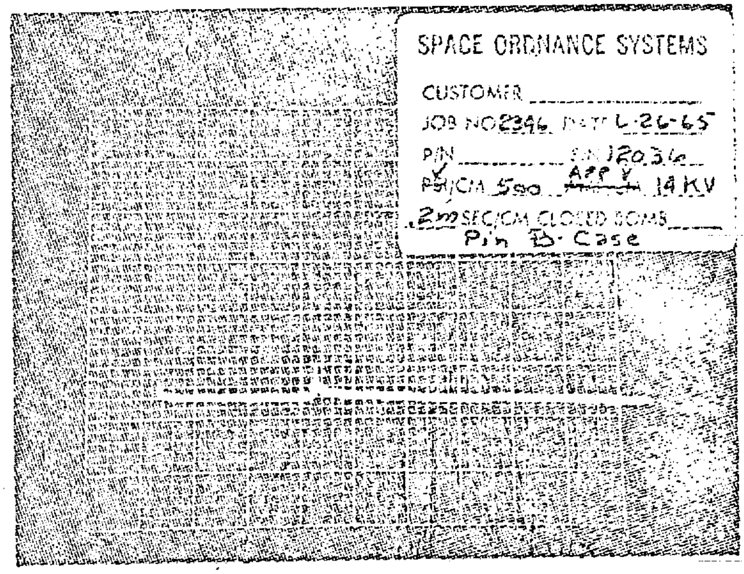

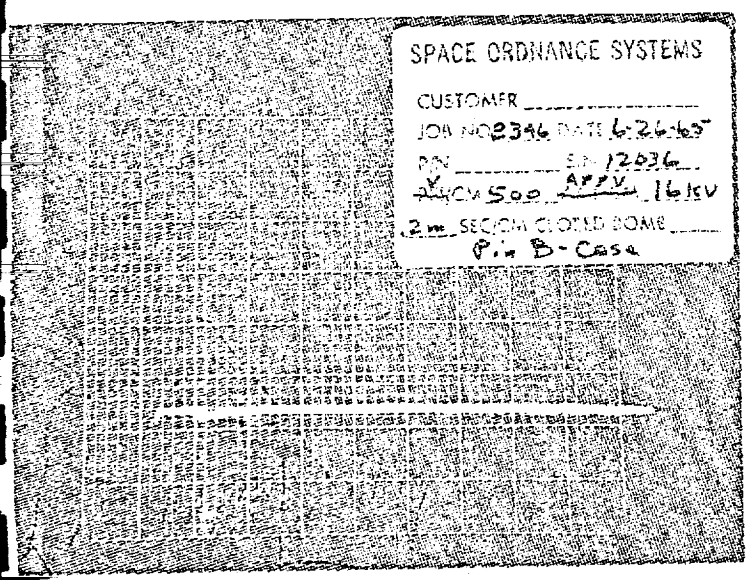

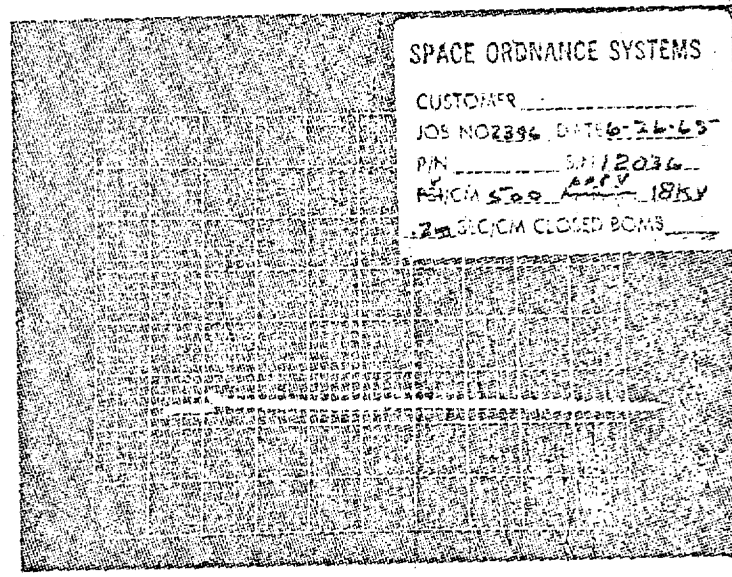

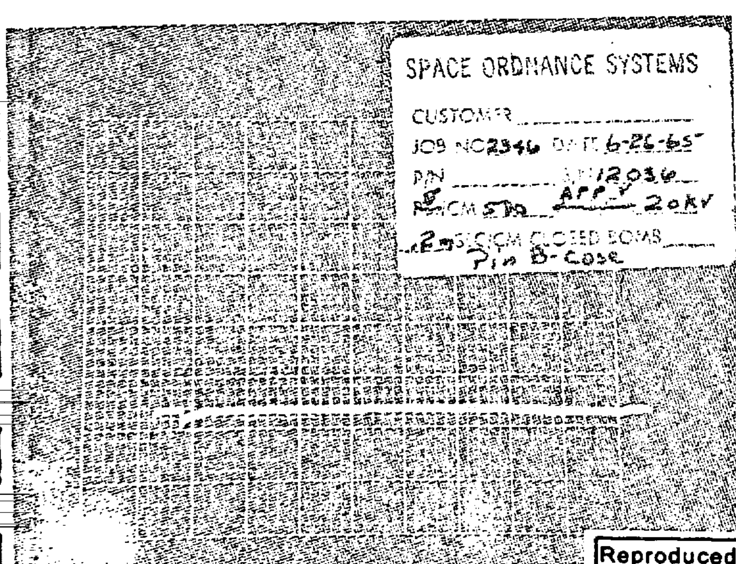

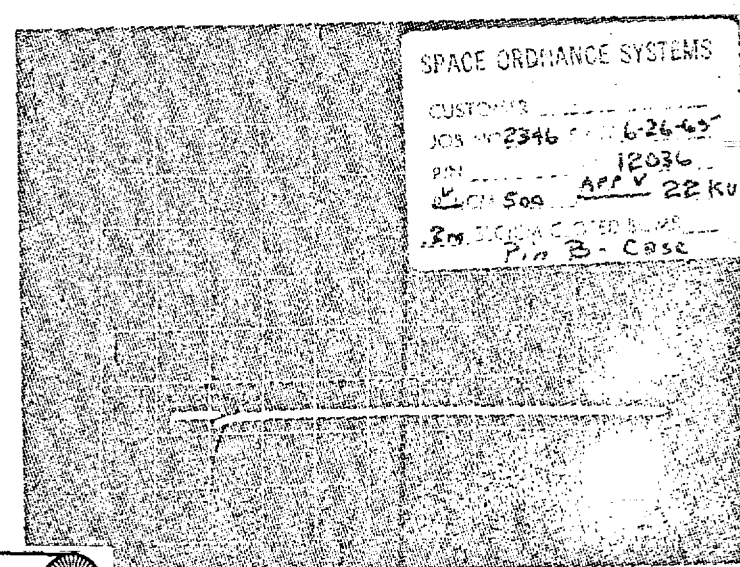

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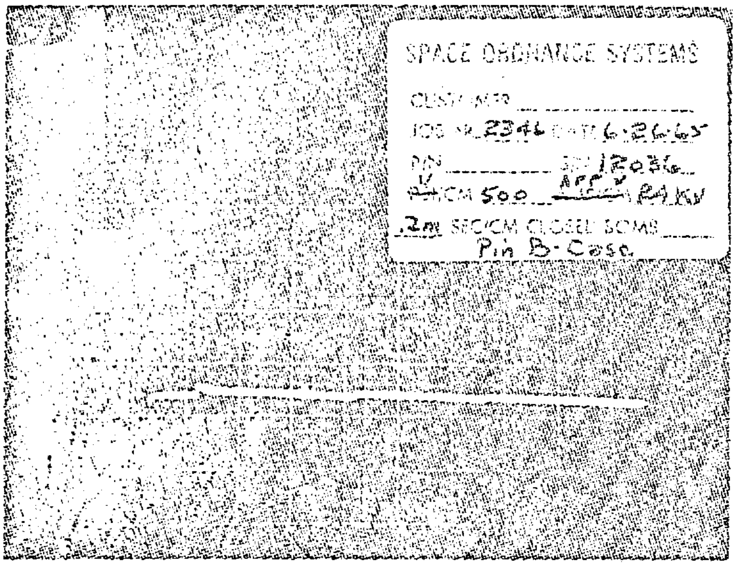

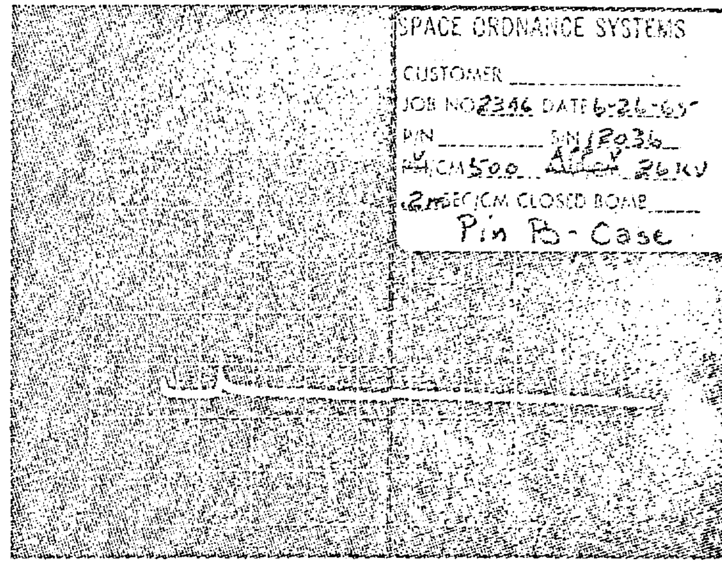

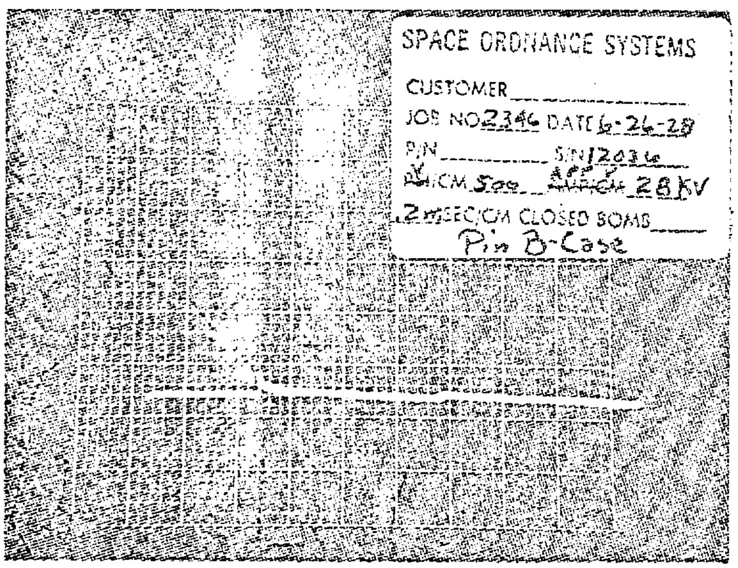

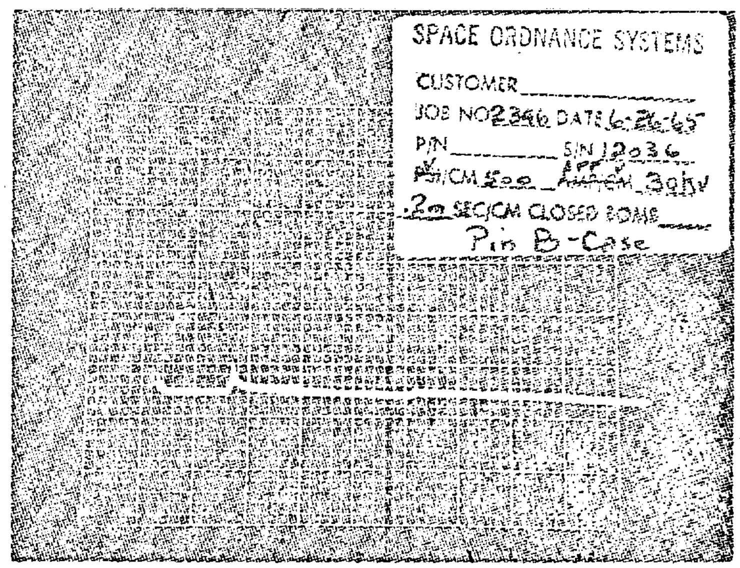

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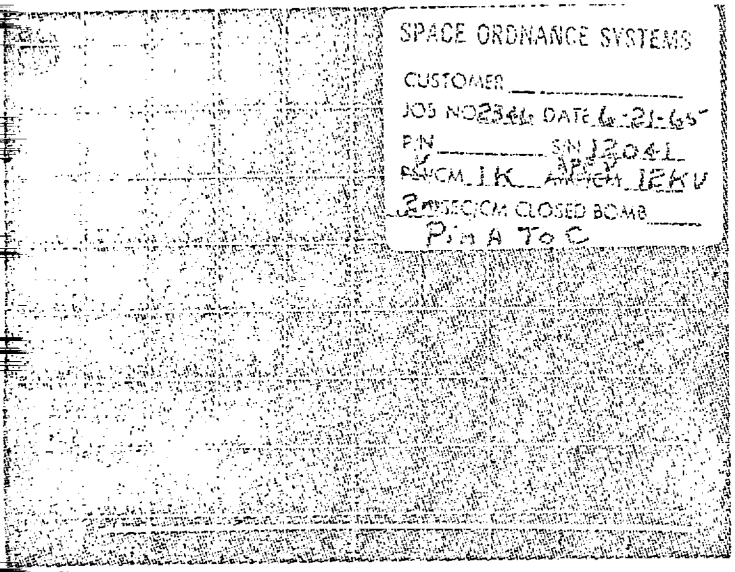

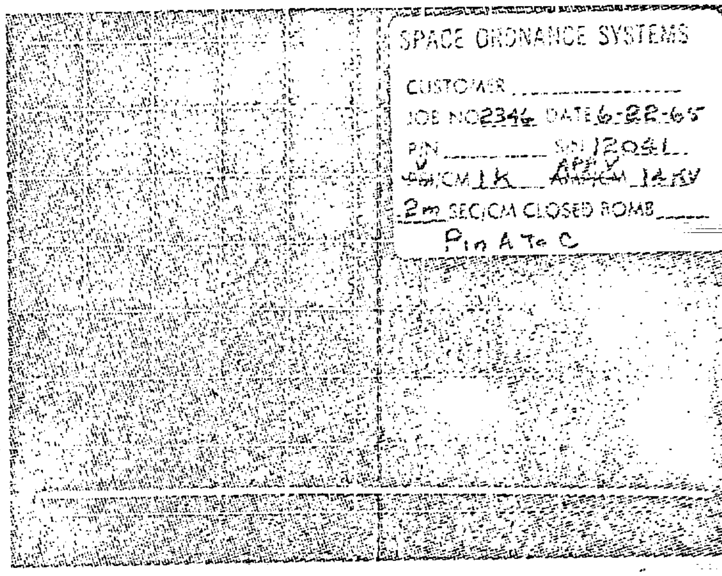

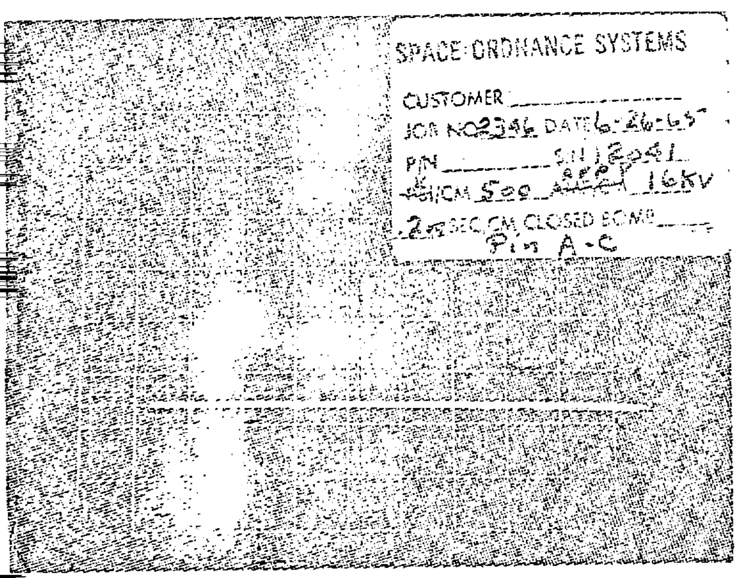

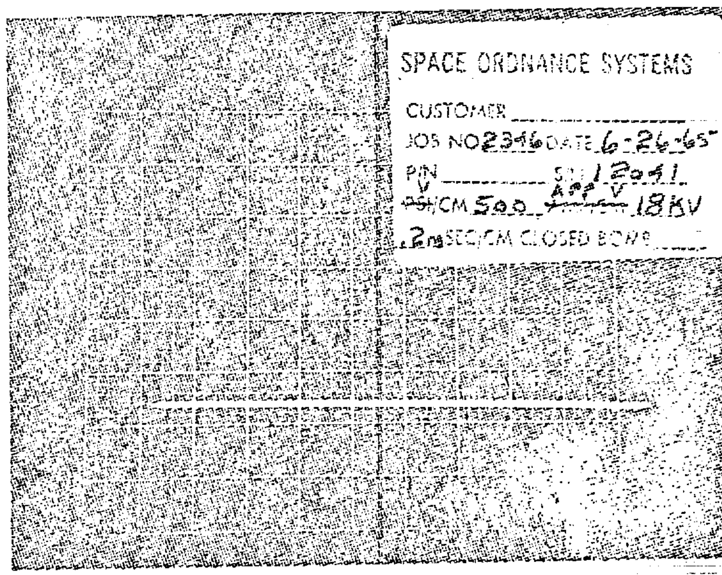

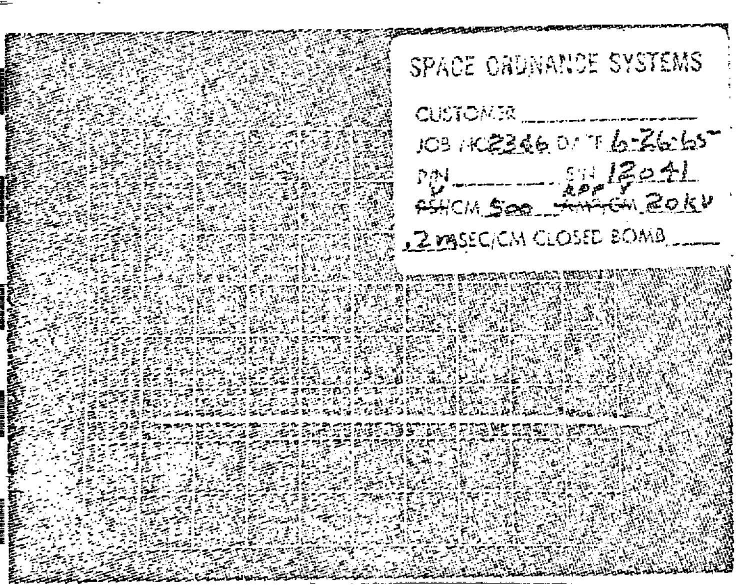

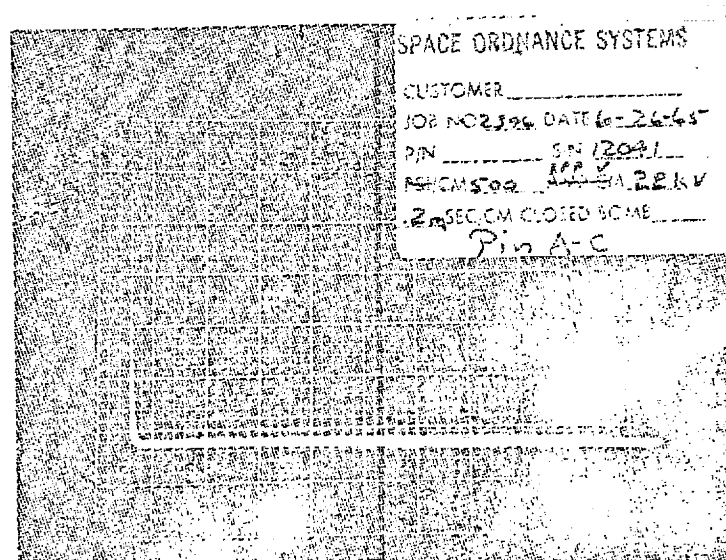

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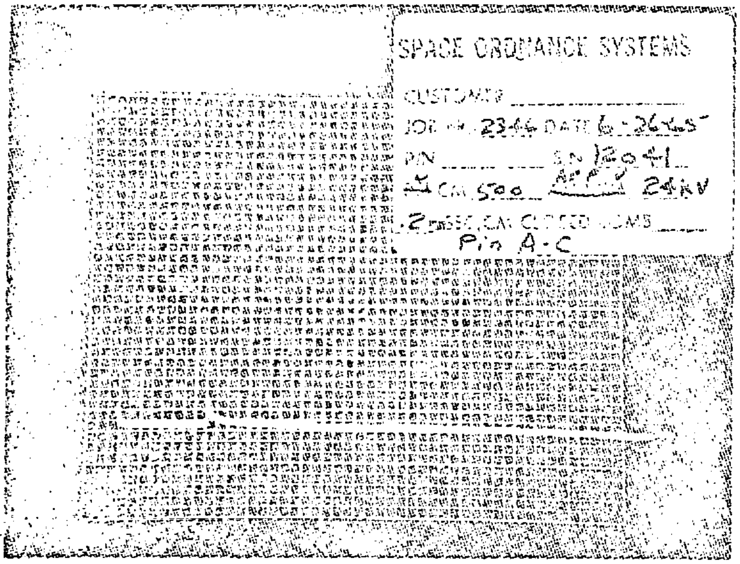

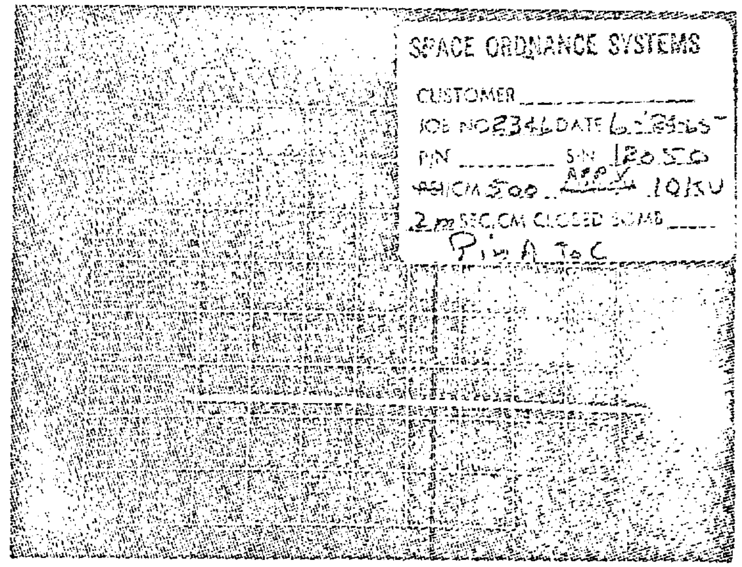

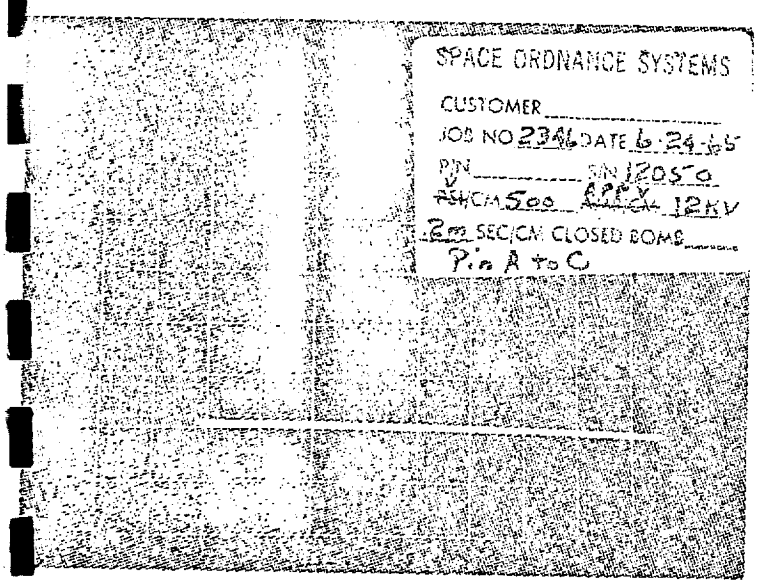

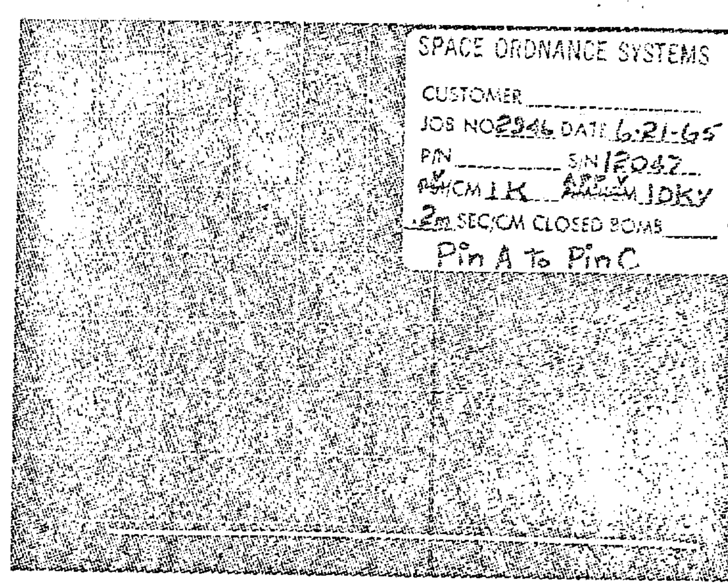

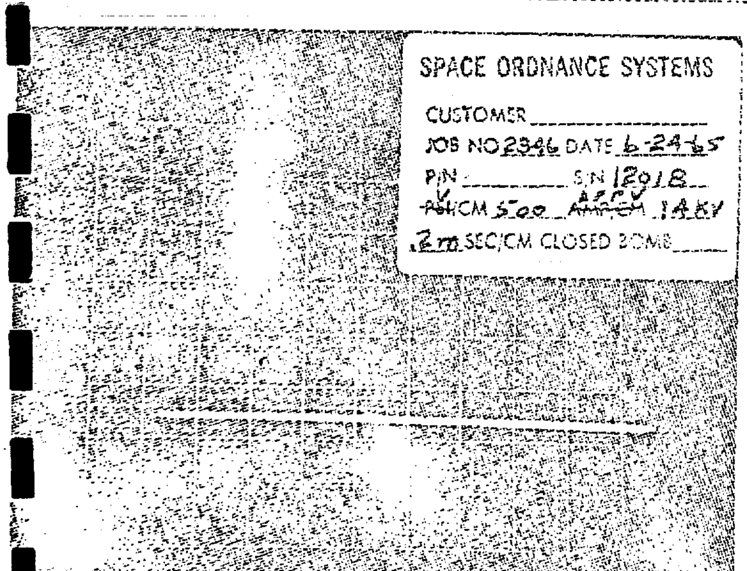

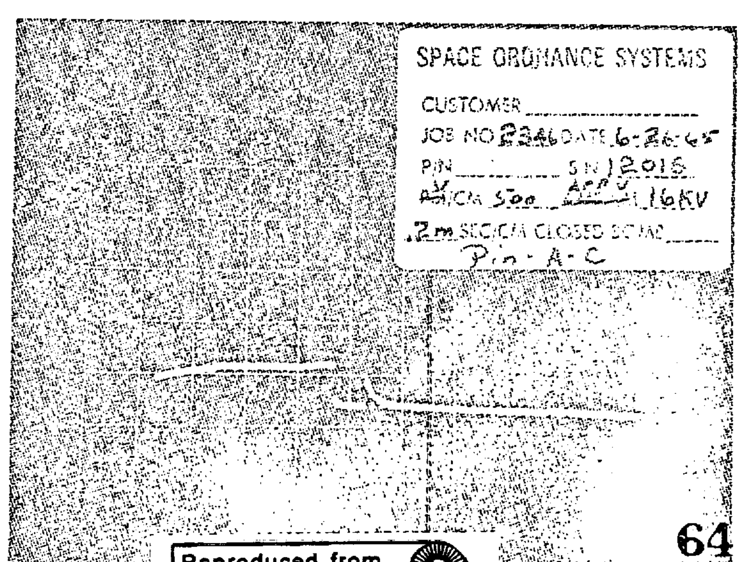

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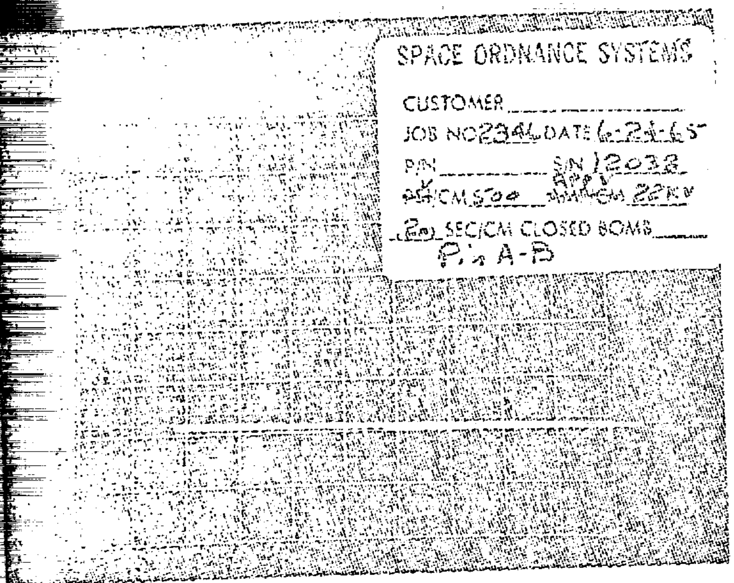

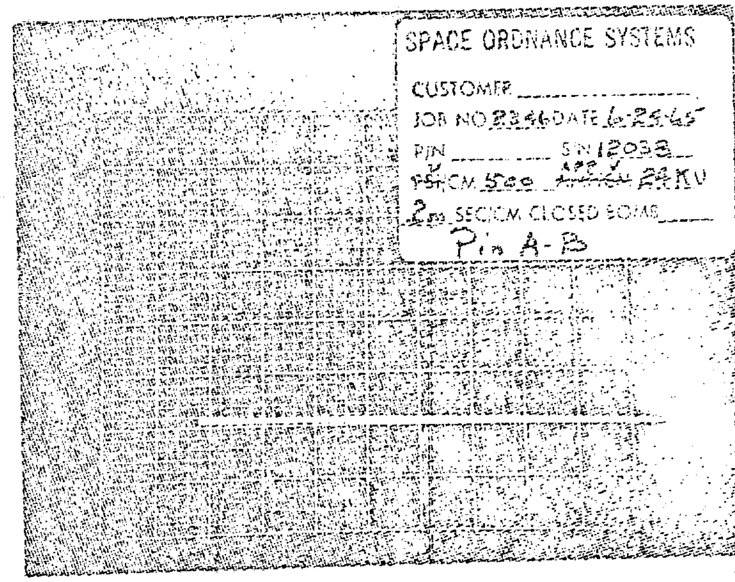

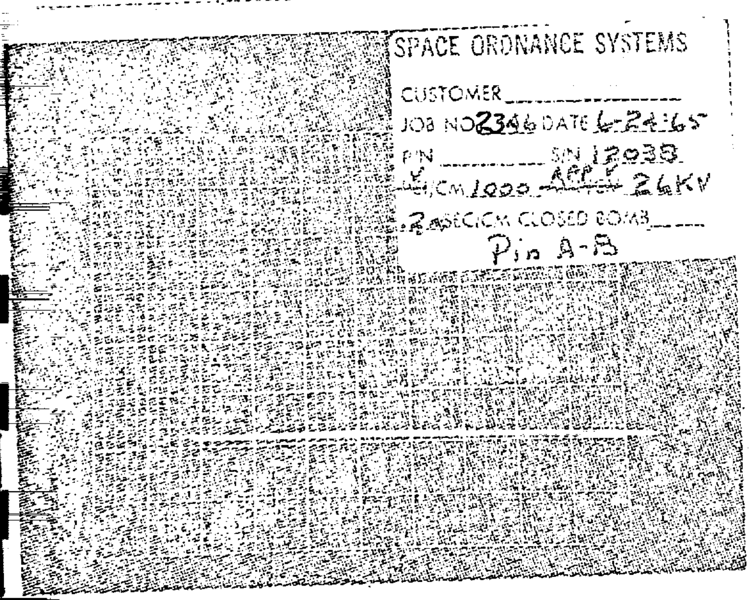

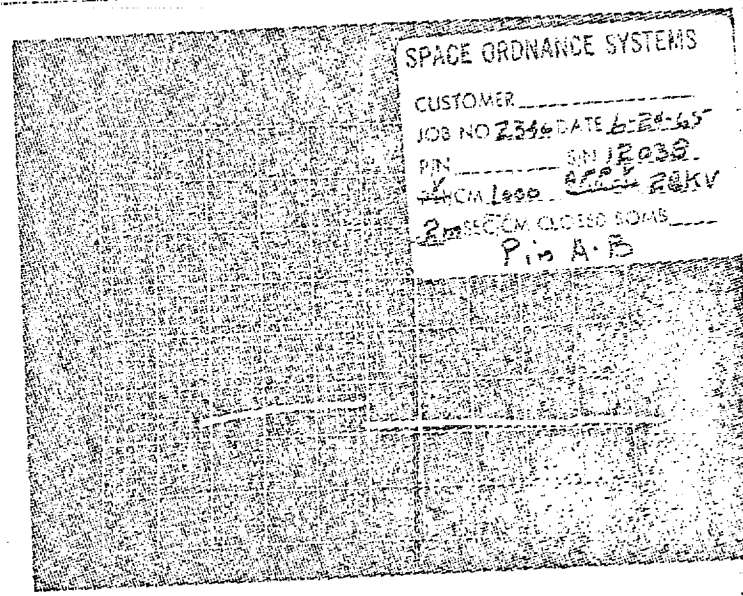

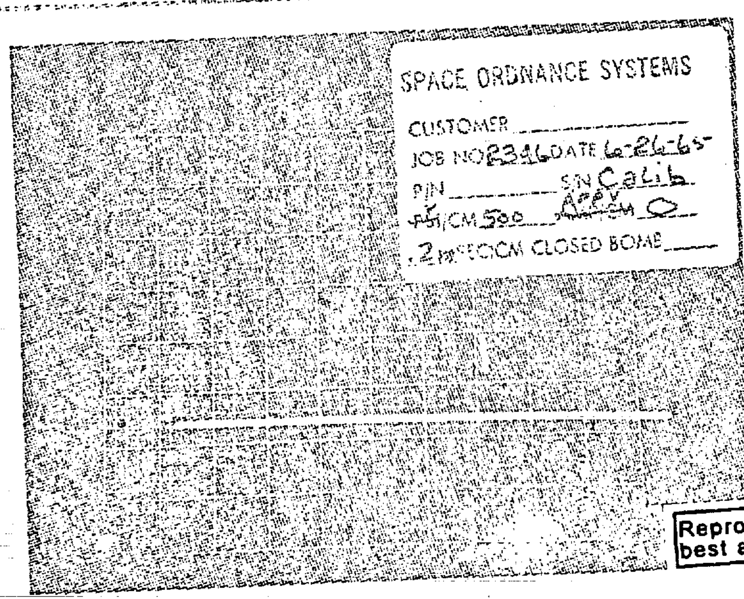

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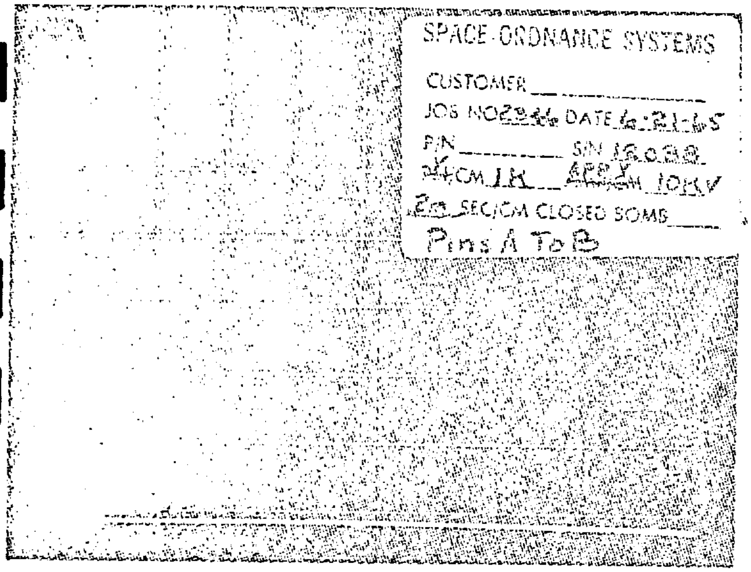

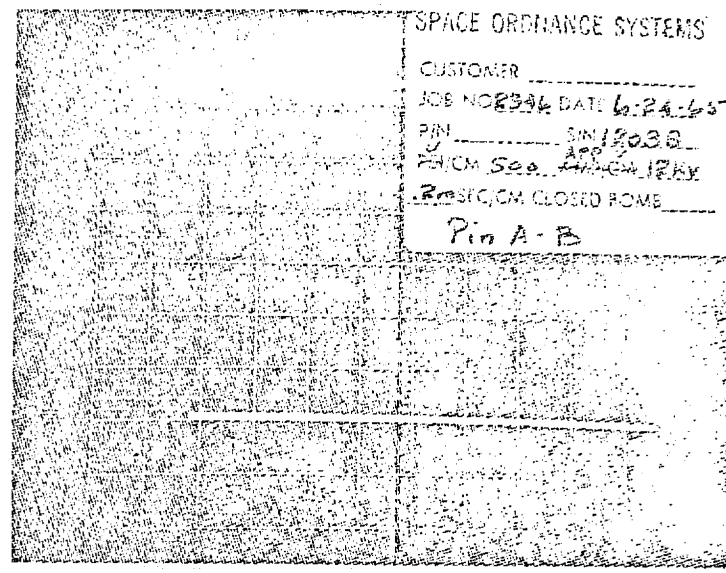

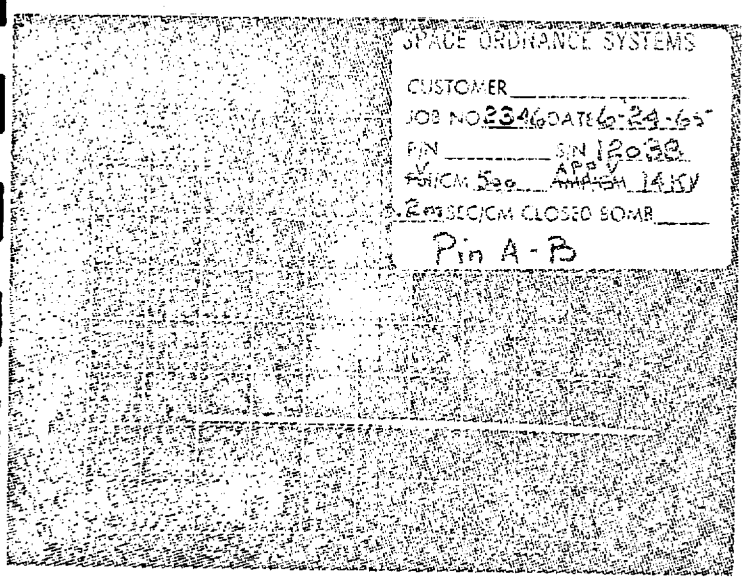

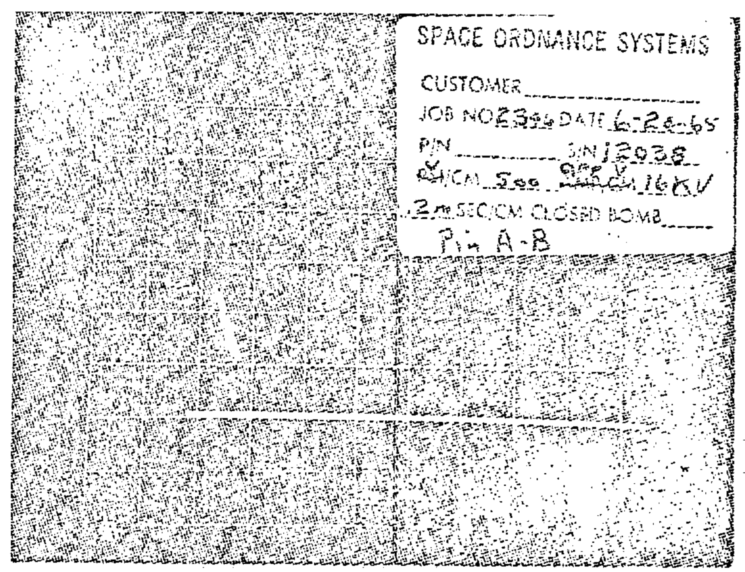

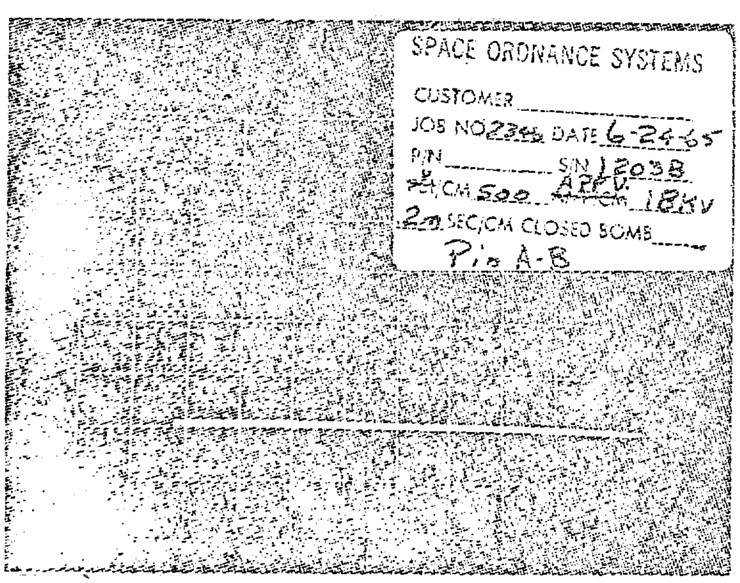

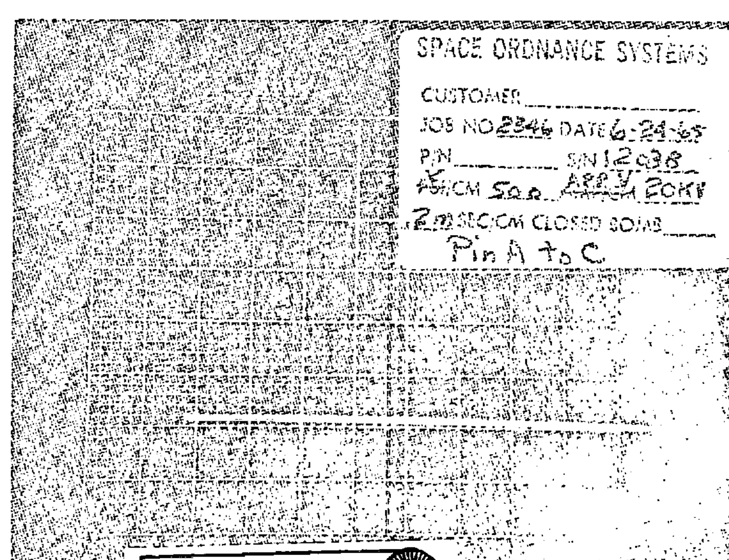

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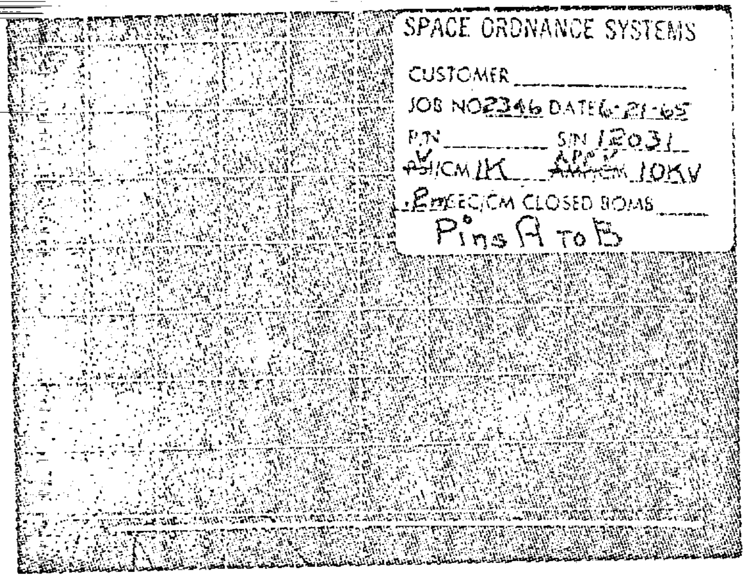

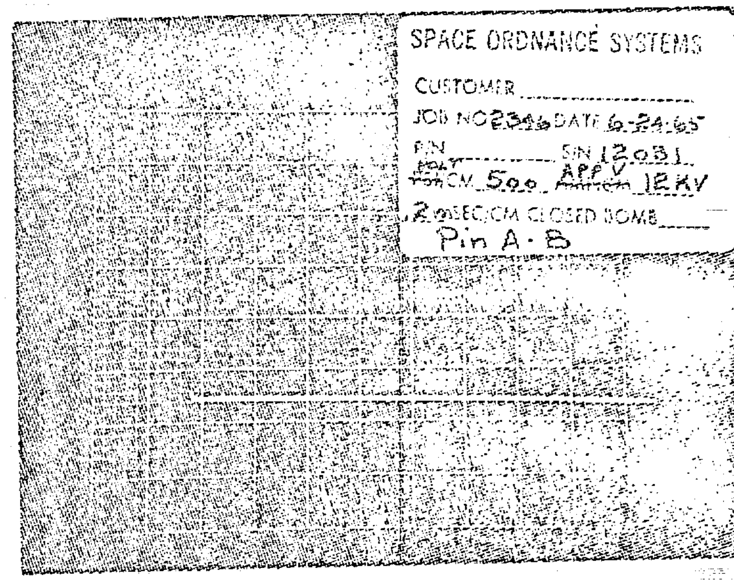

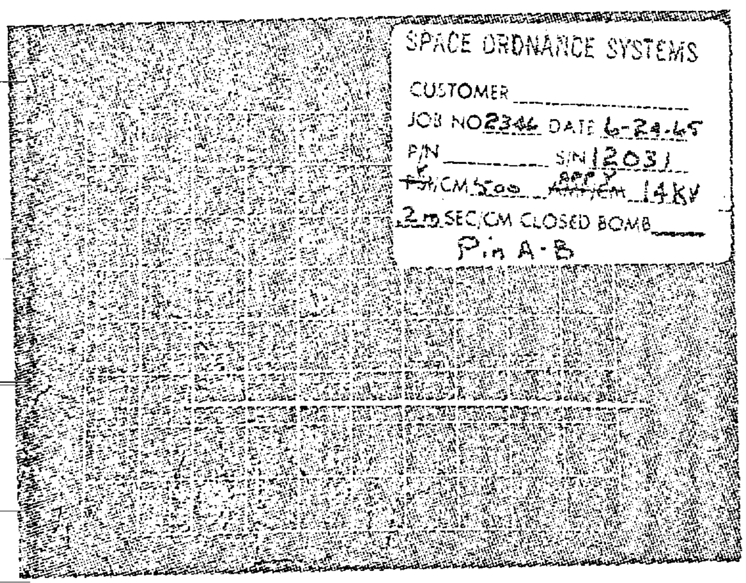

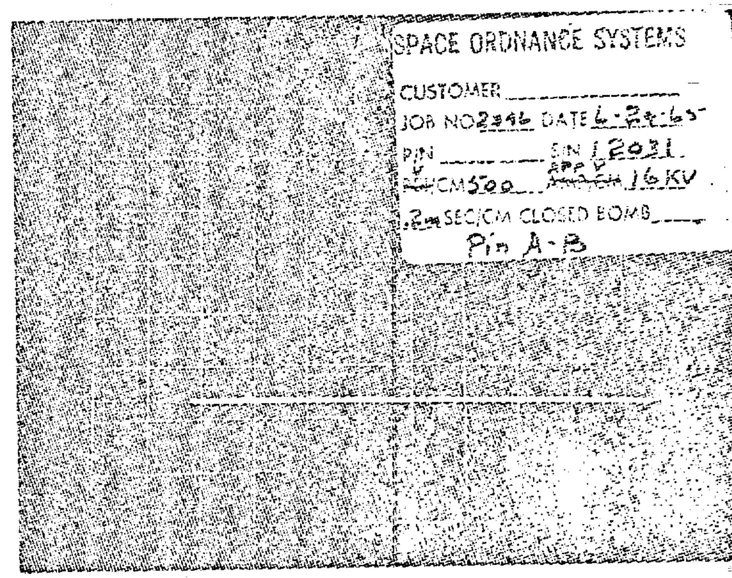

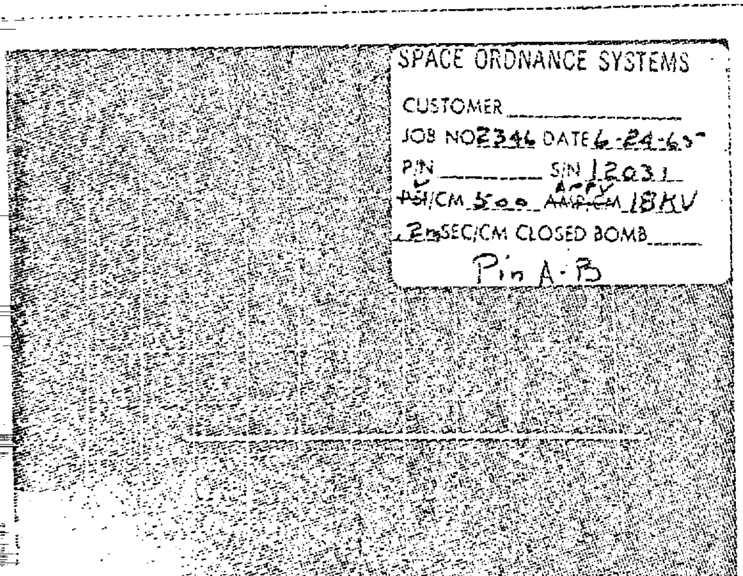

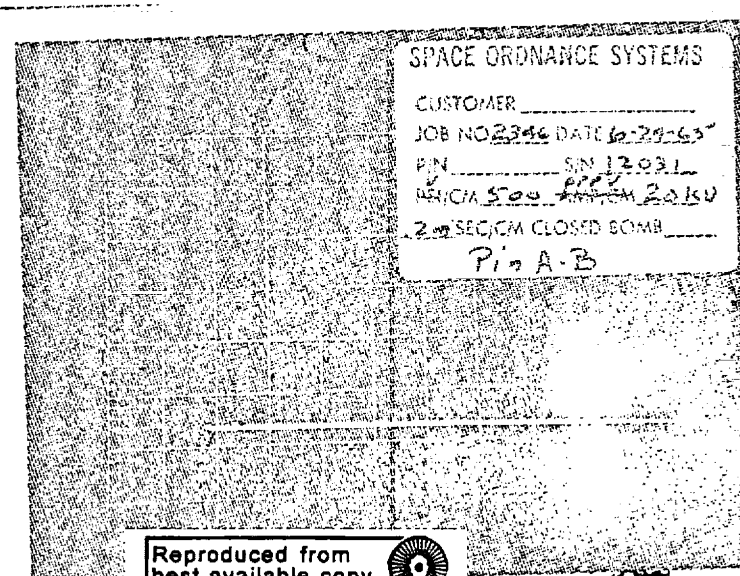

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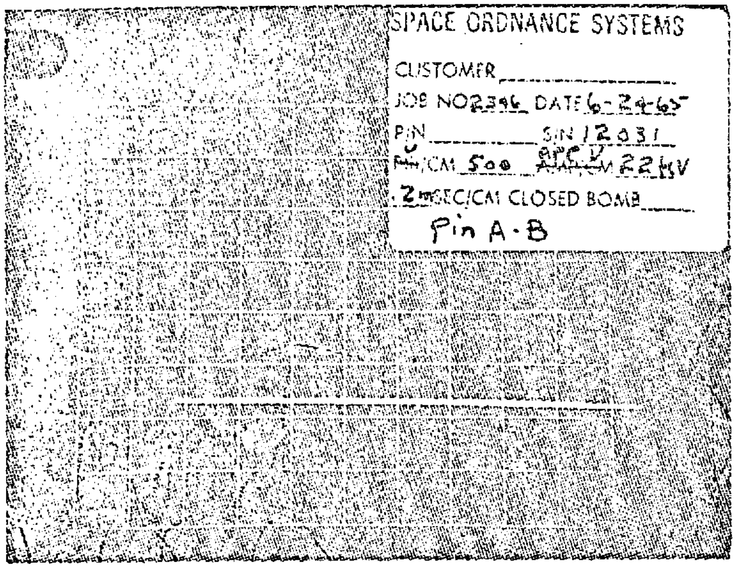

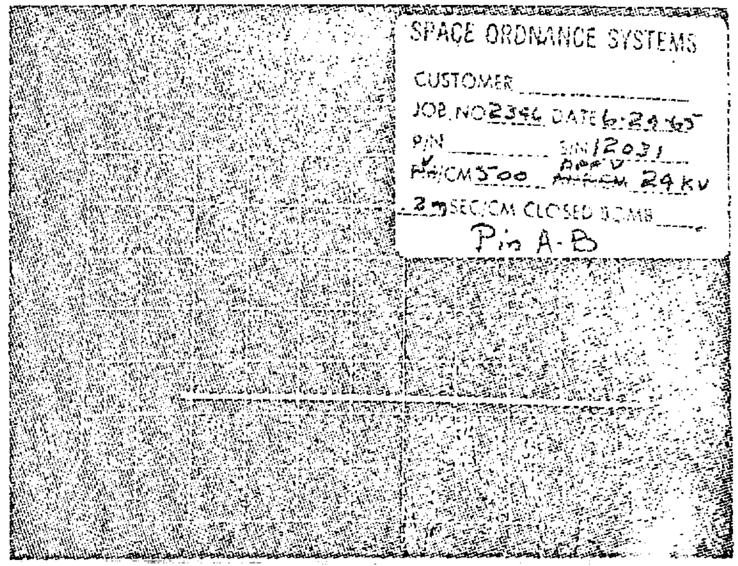

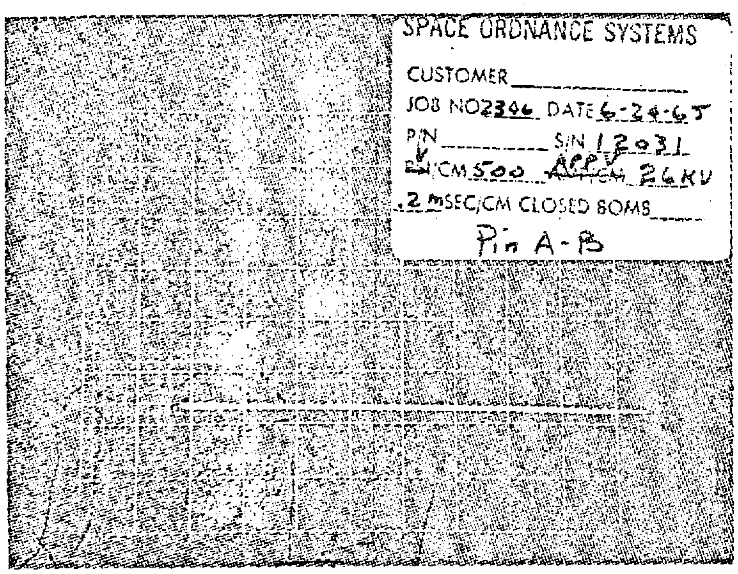

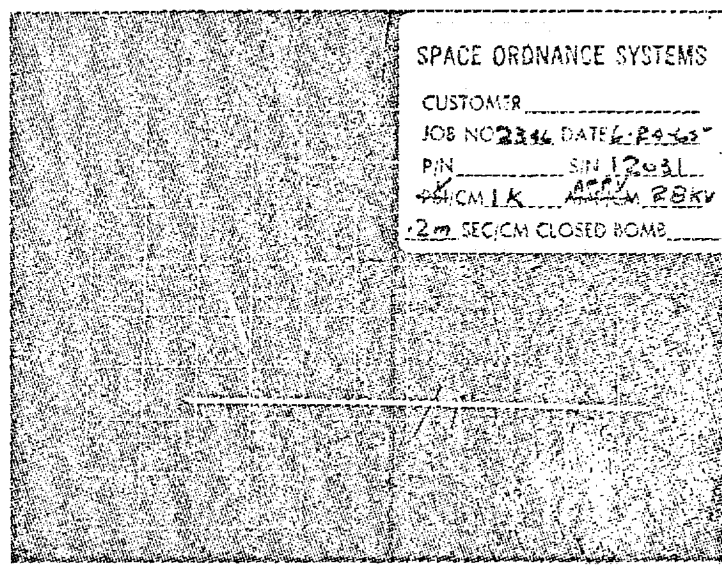

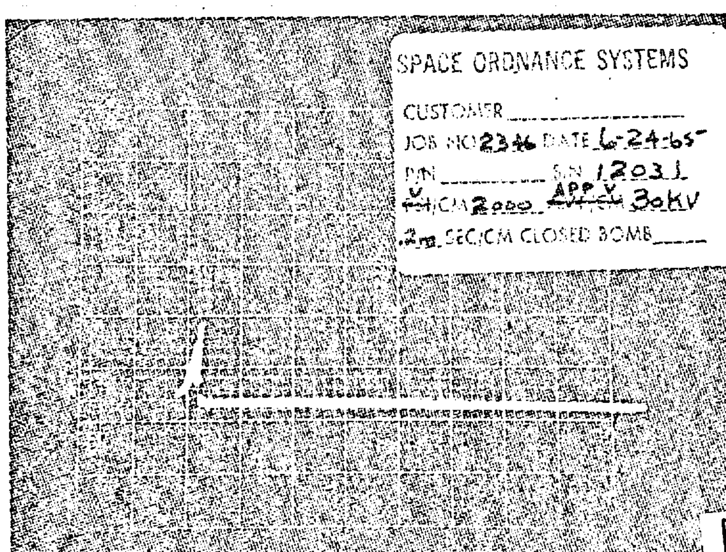

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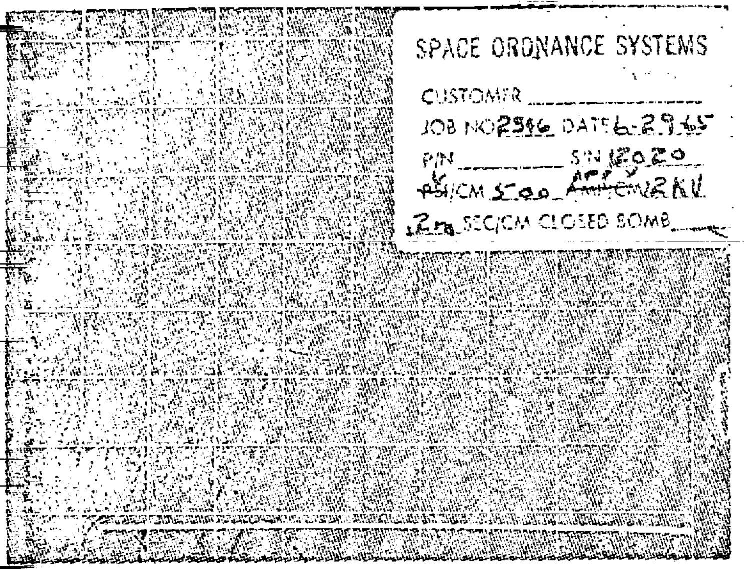

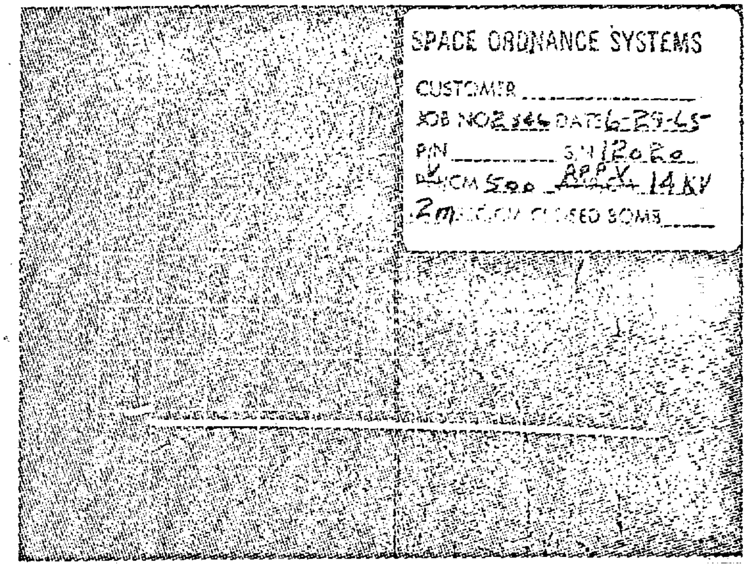

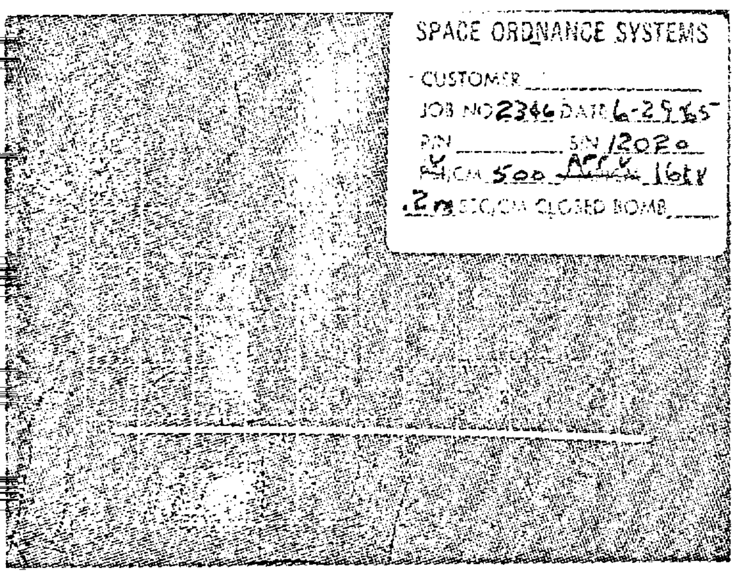

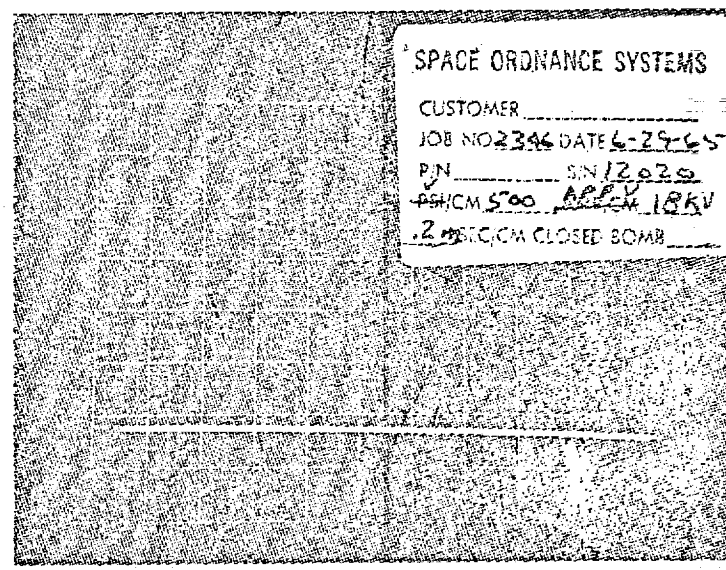

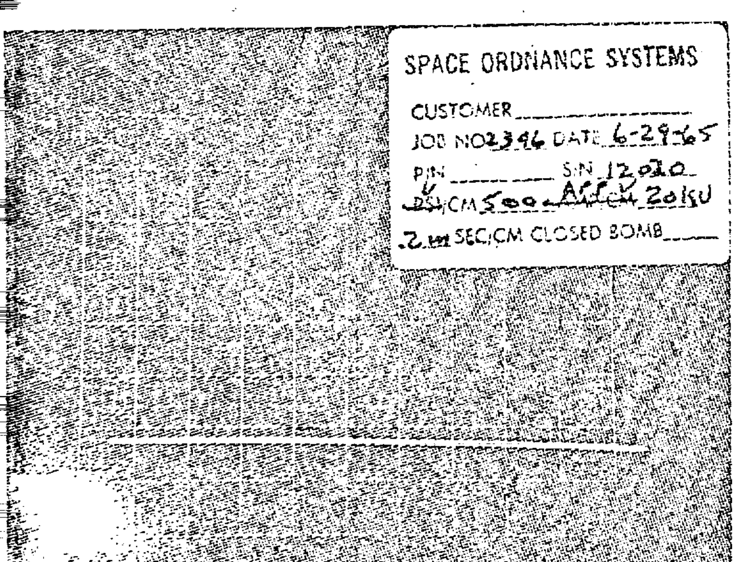

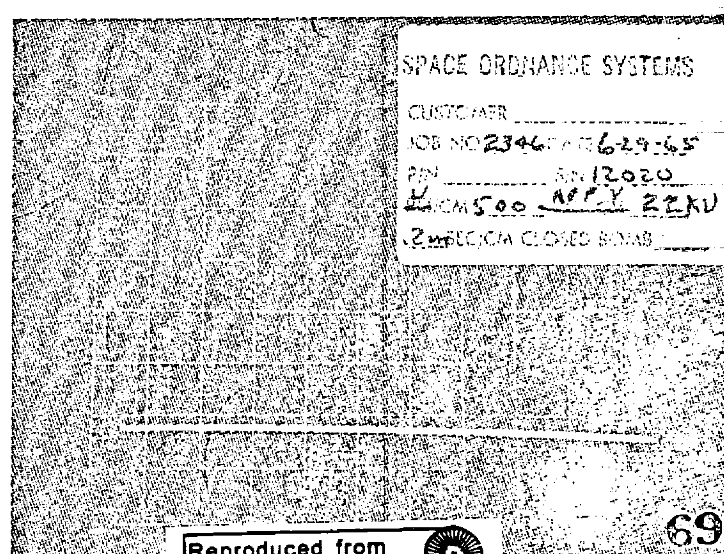

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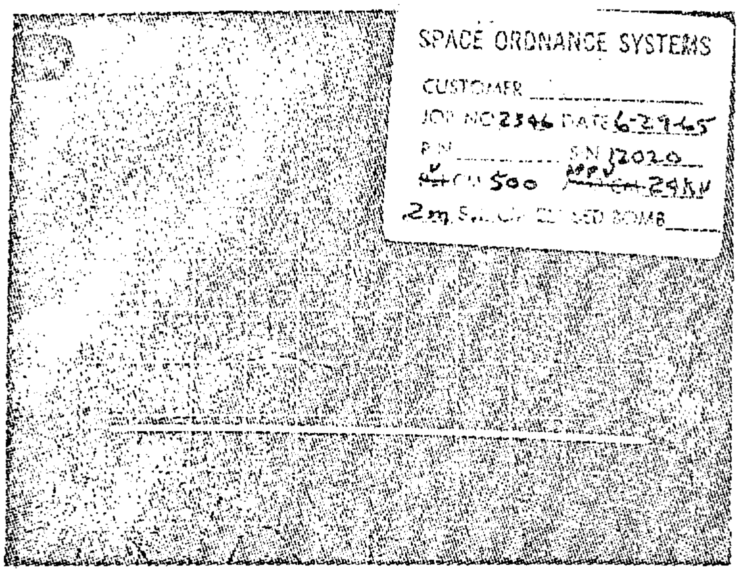

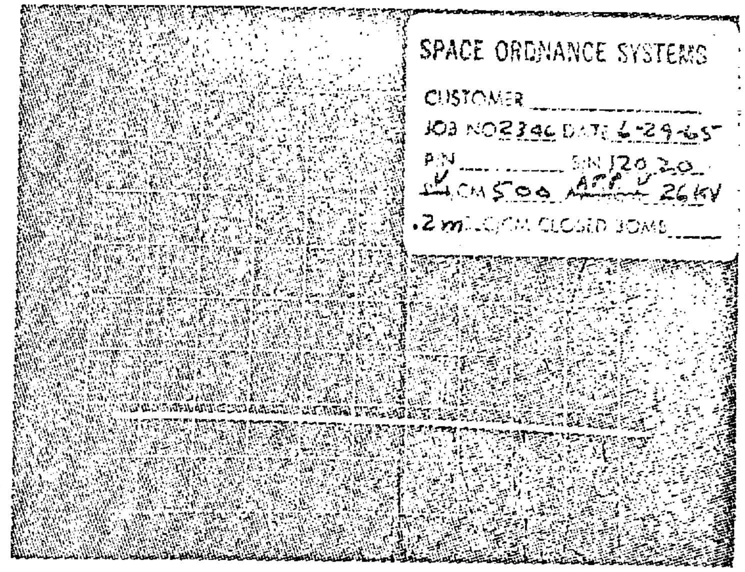

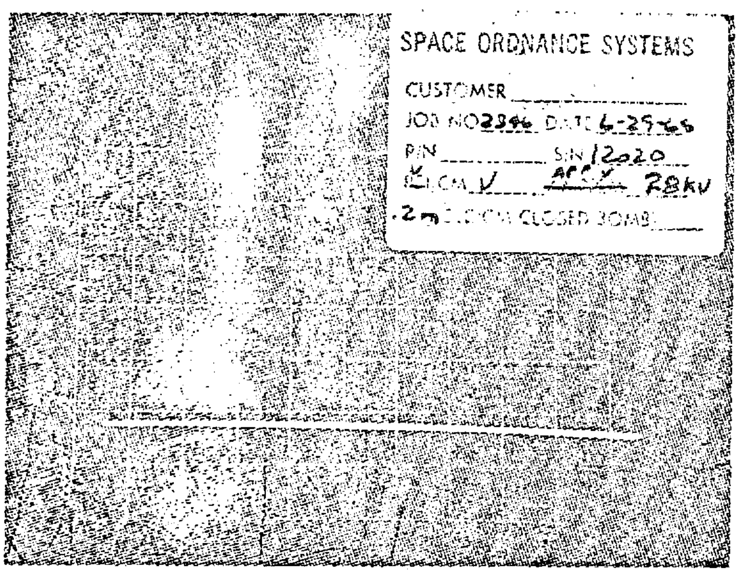

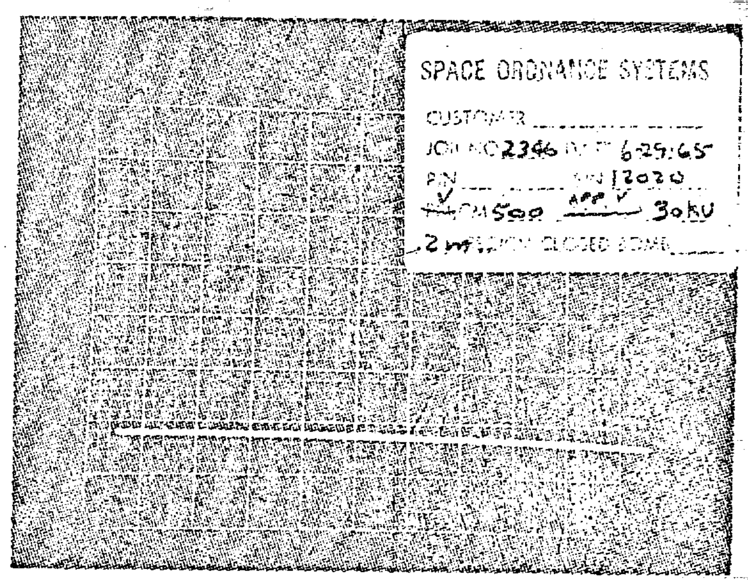

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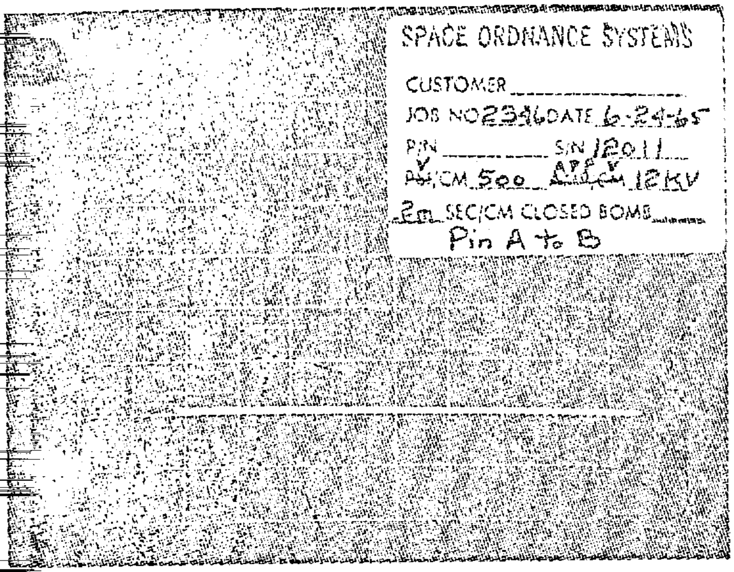

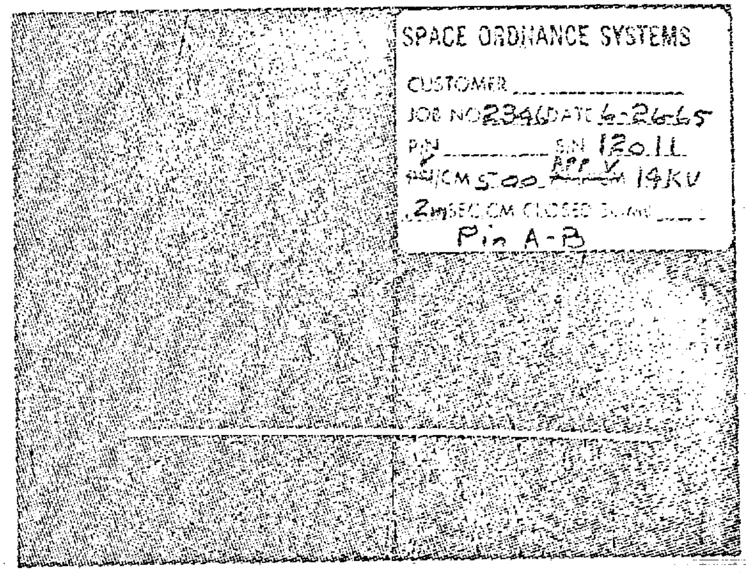

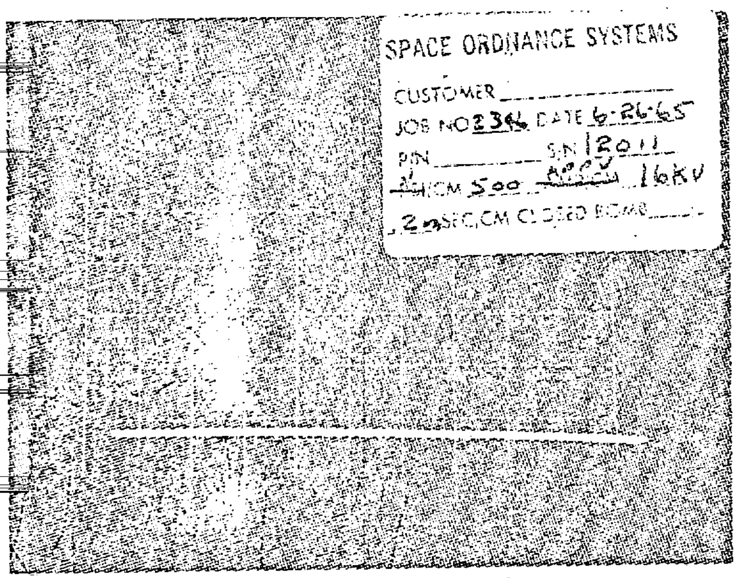

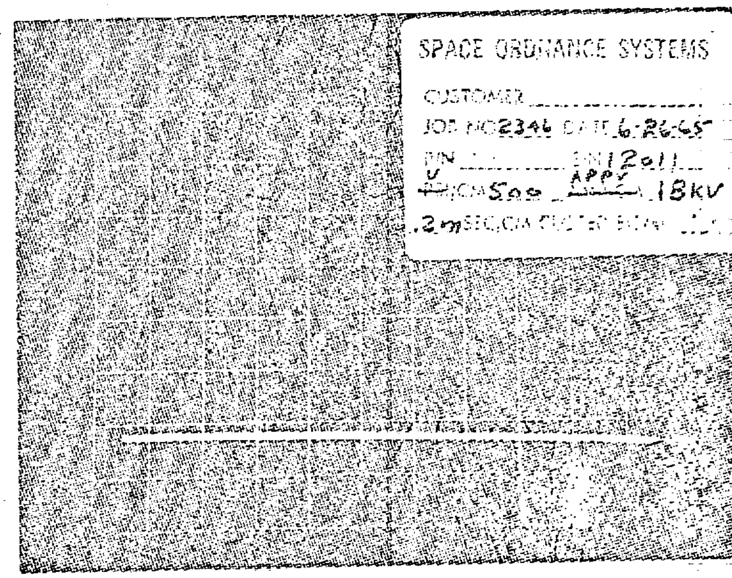

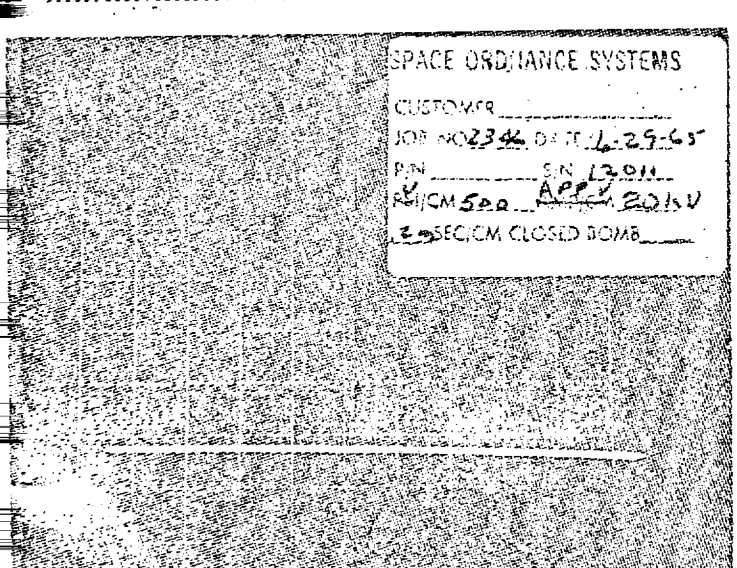

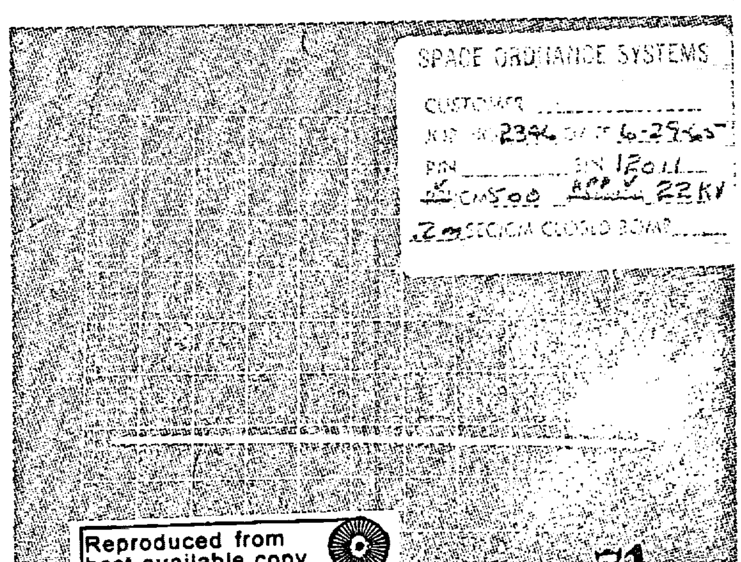

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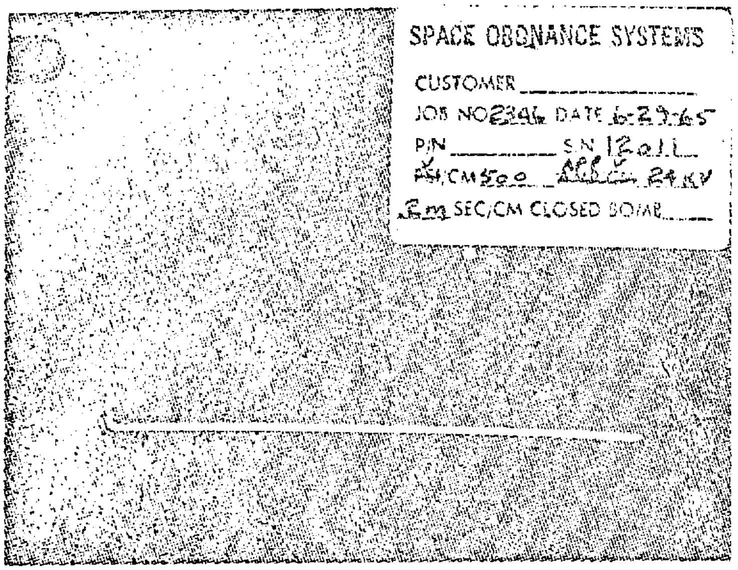

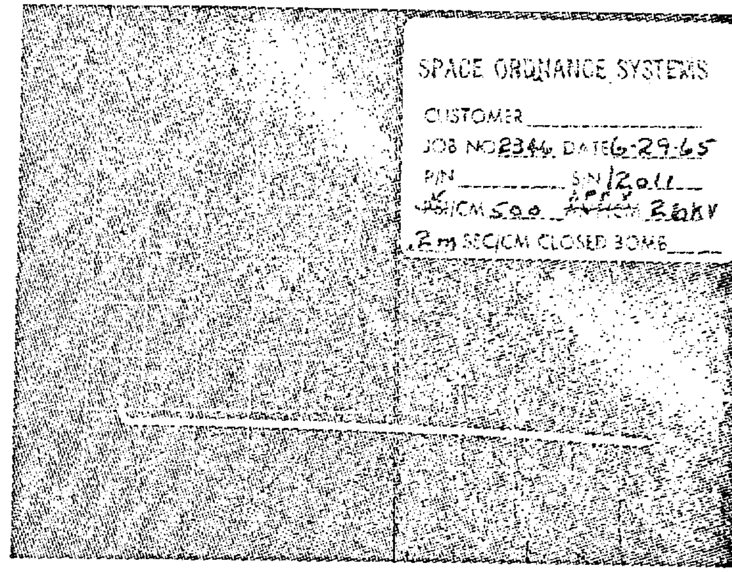

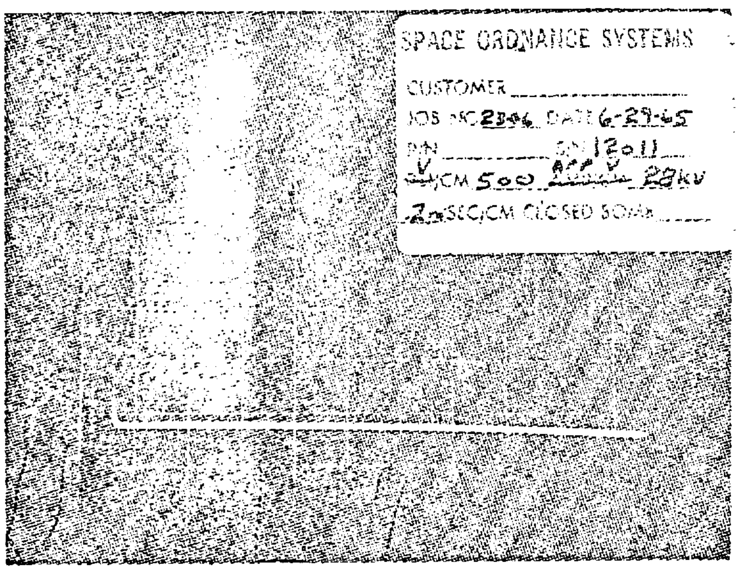

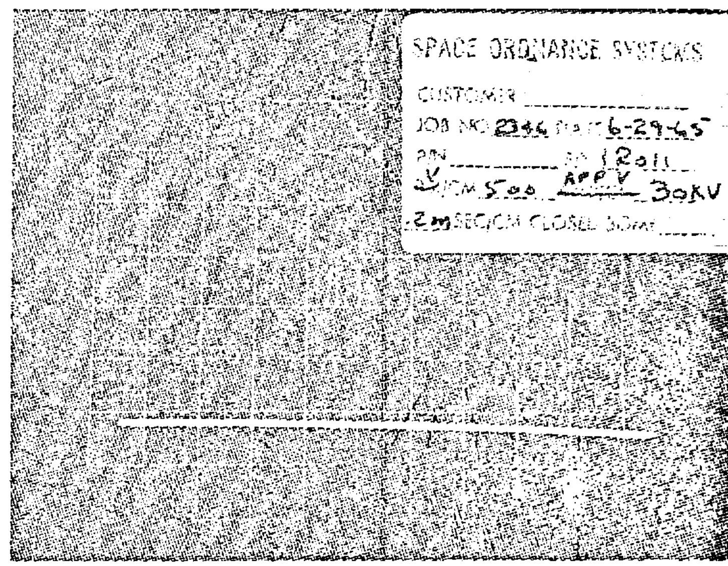

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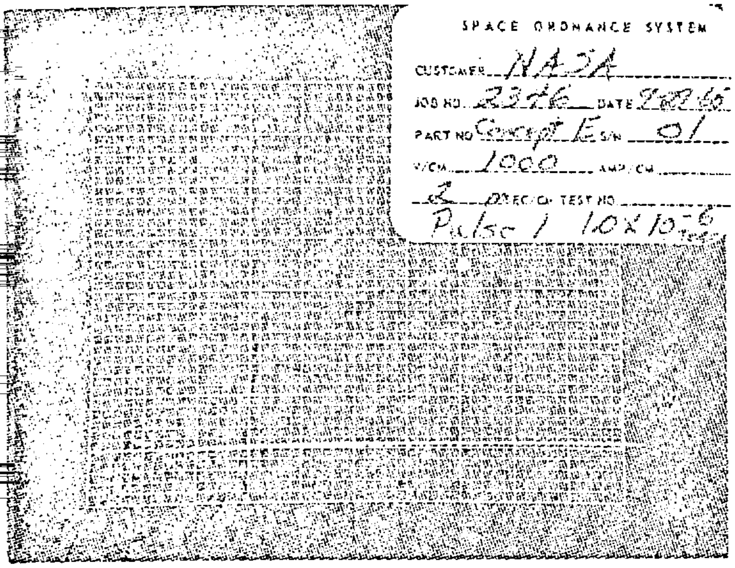

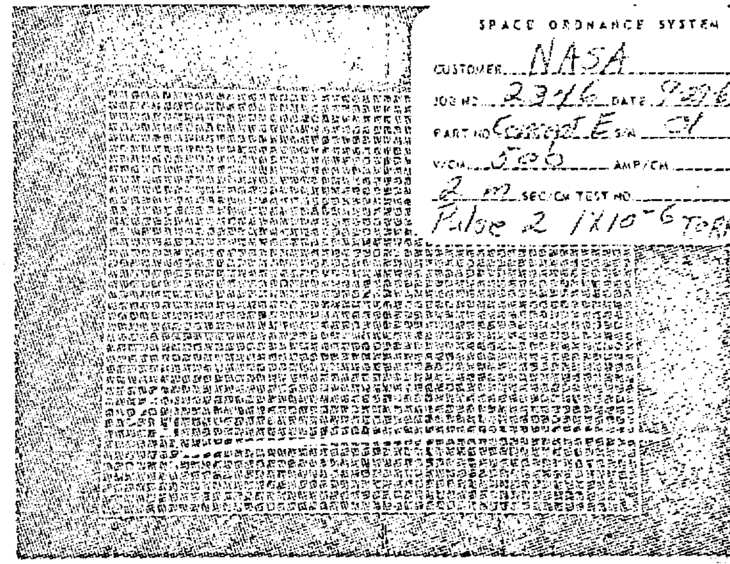

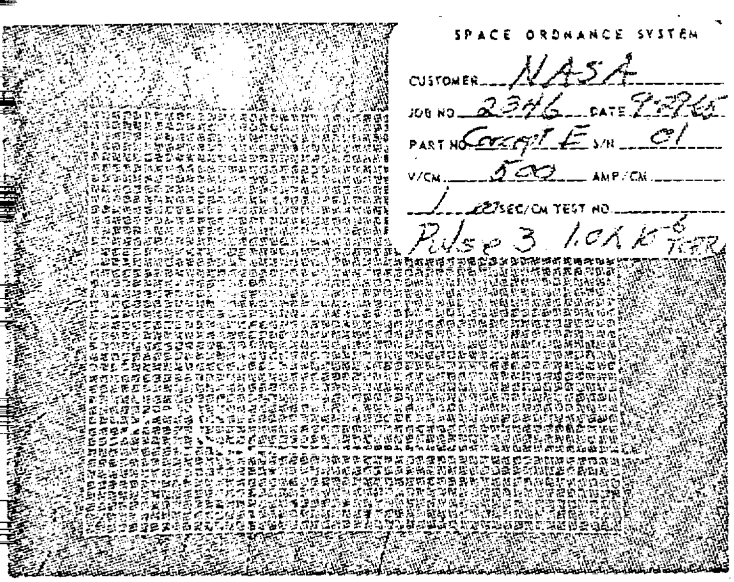

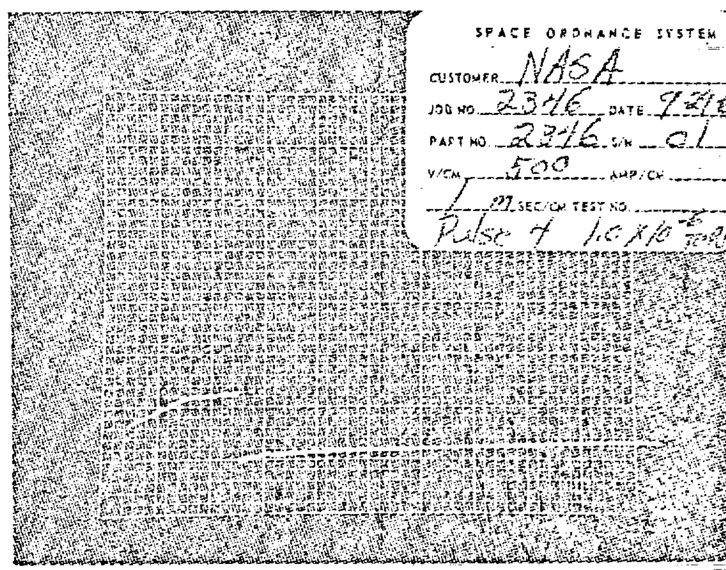

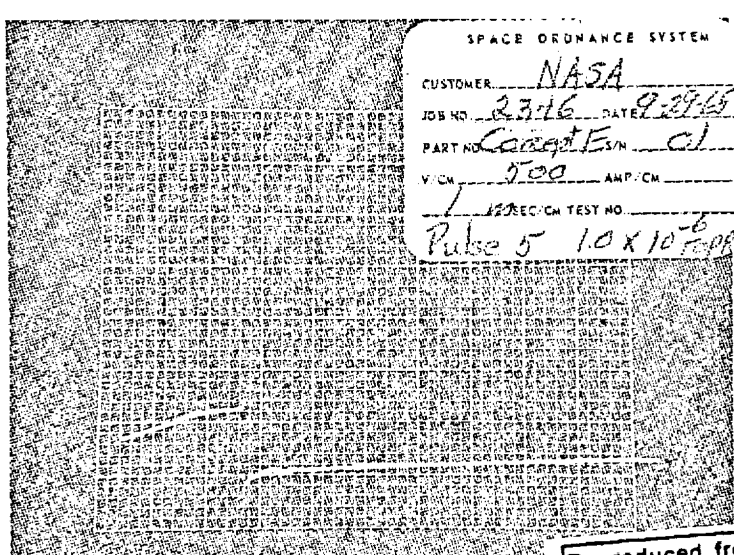

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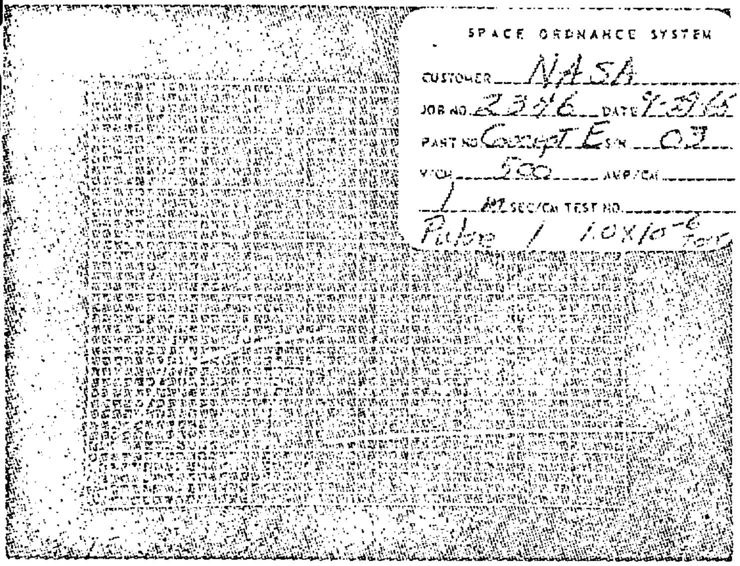
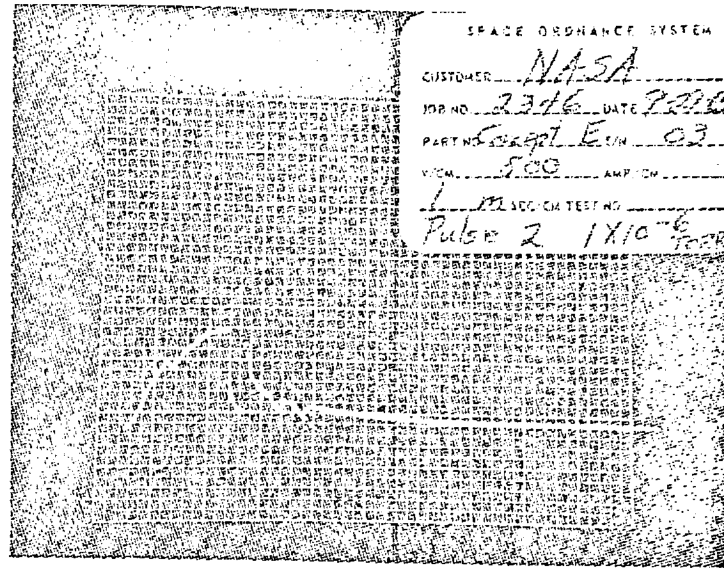
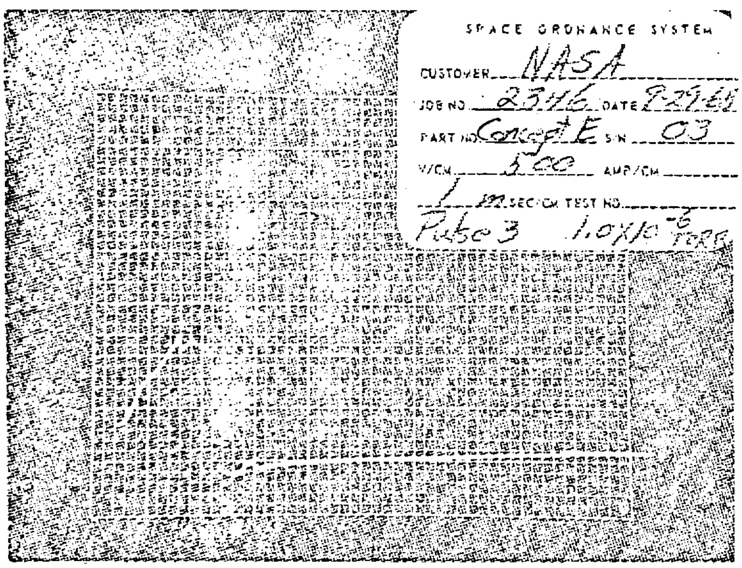
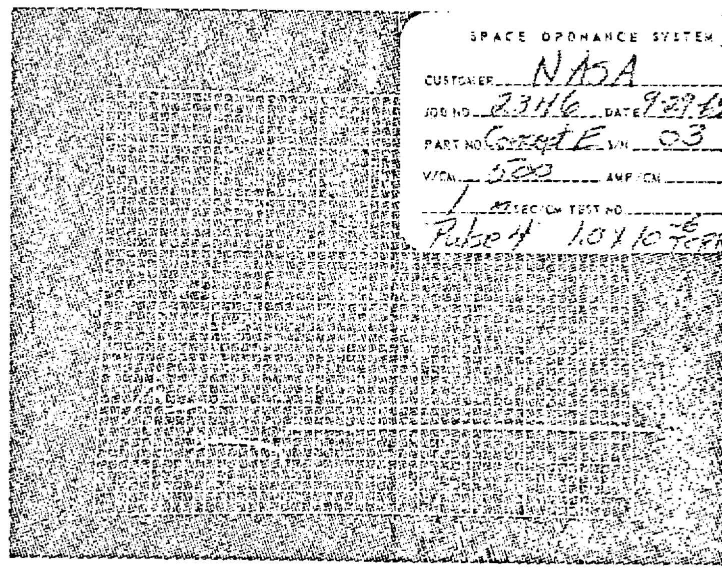
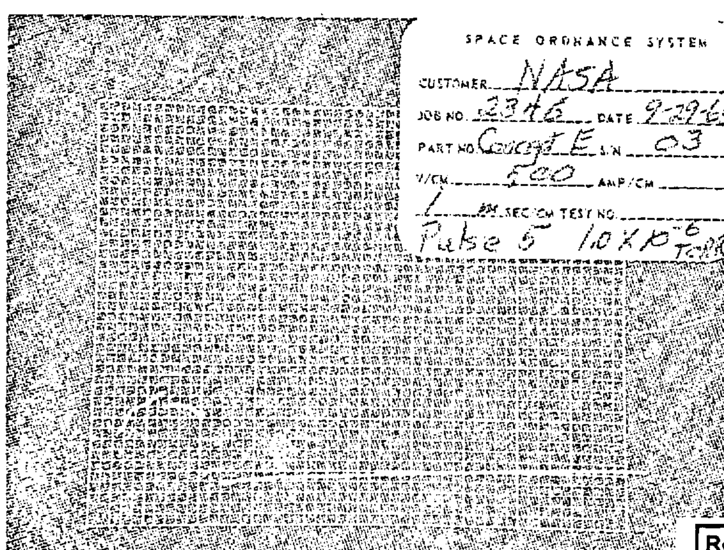
SPACE ORDNANCE SYSTEMS, INC.











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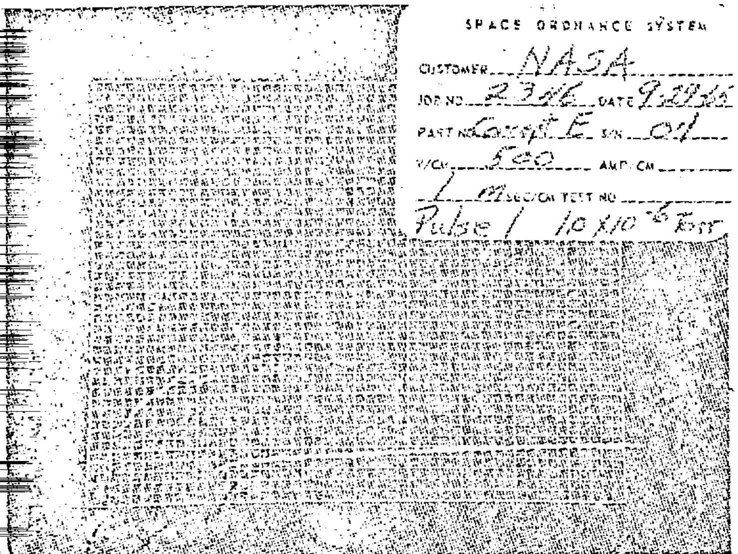
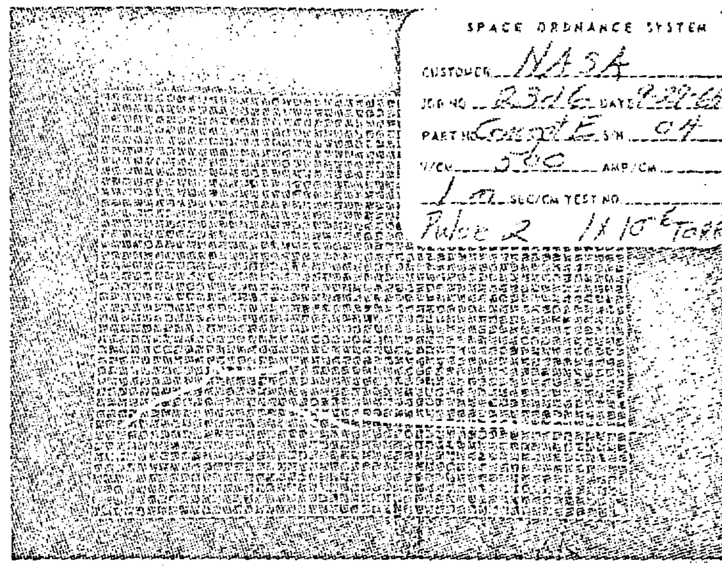
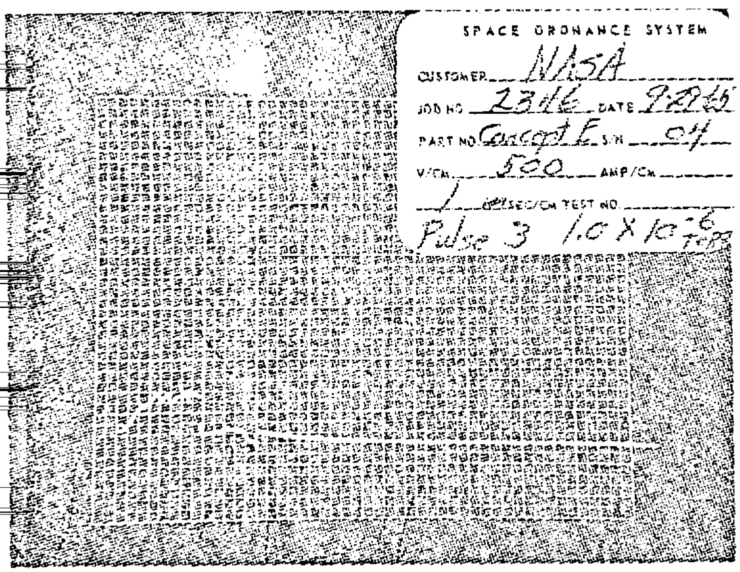
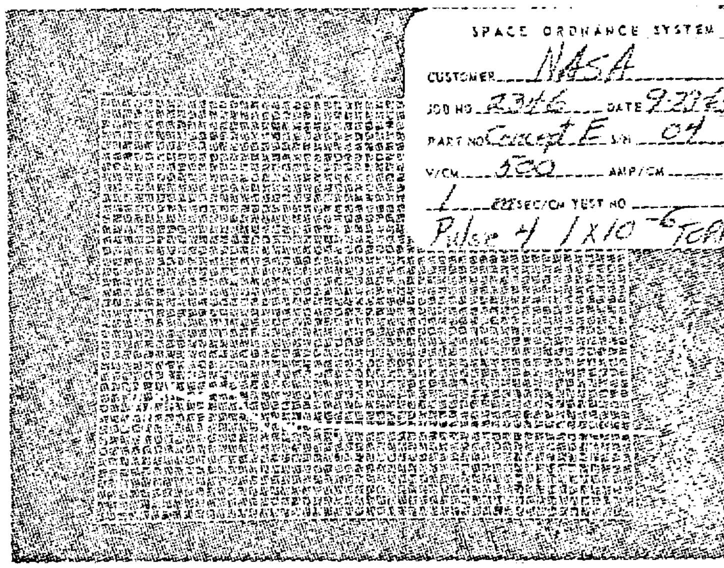
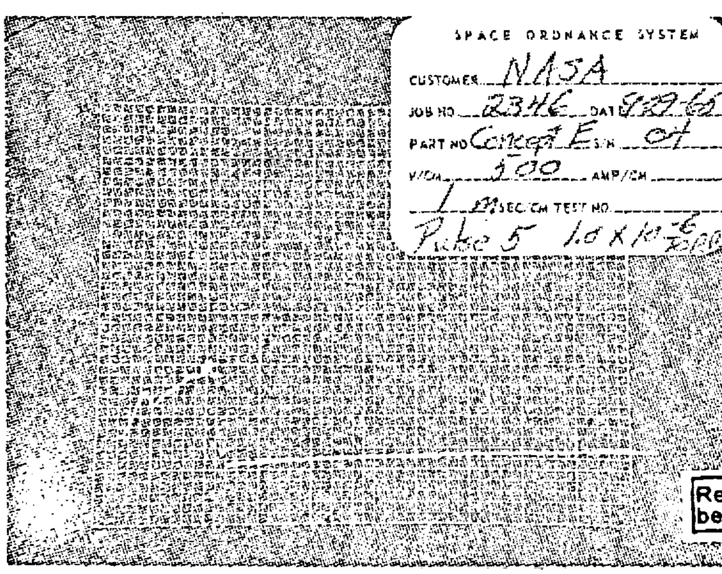
SPACE ORDNANCE SYSTEMS, INC.











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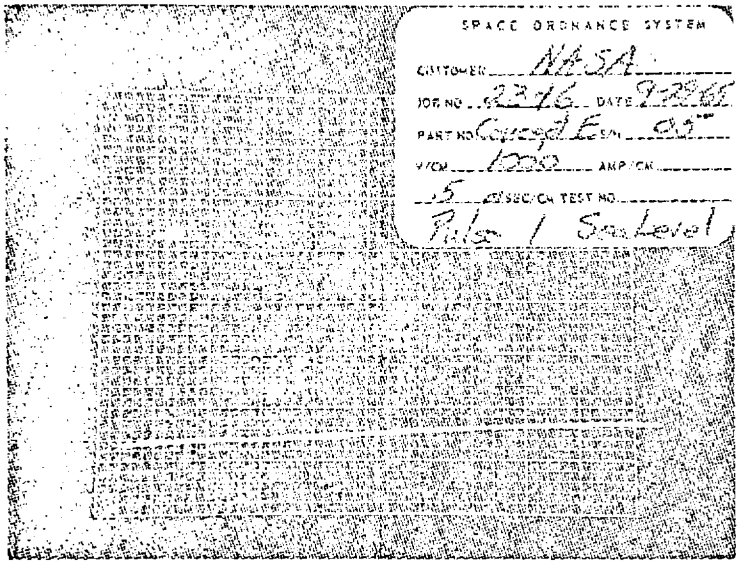
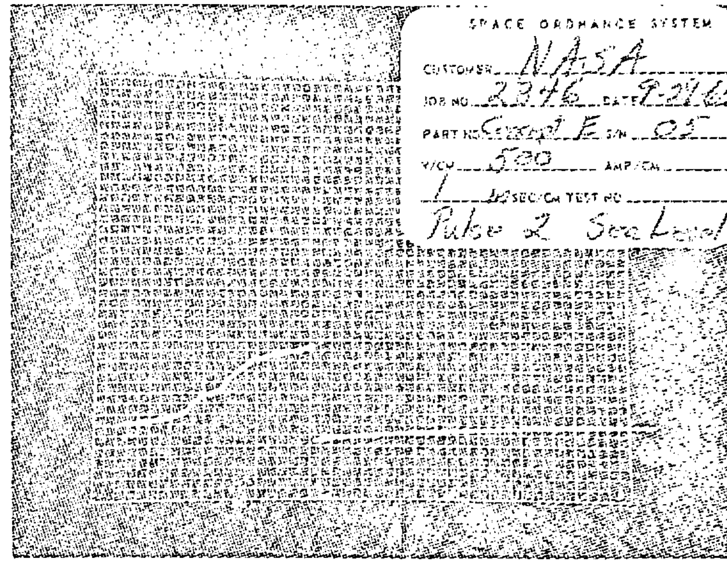
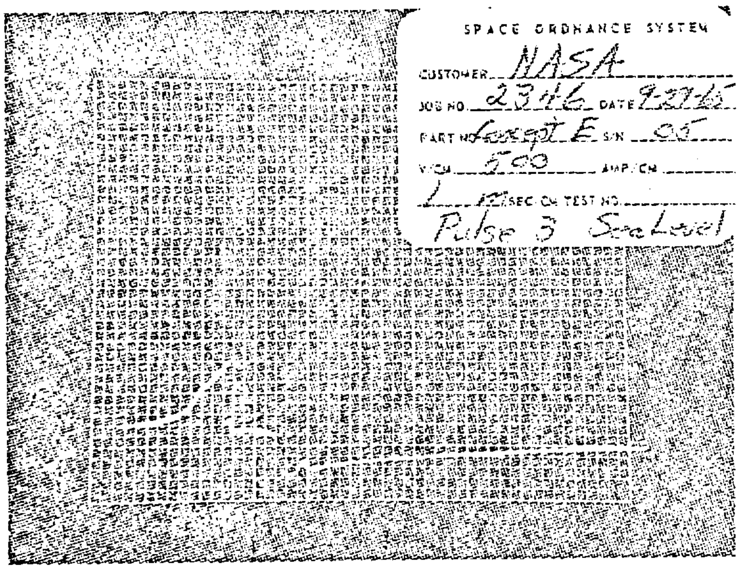
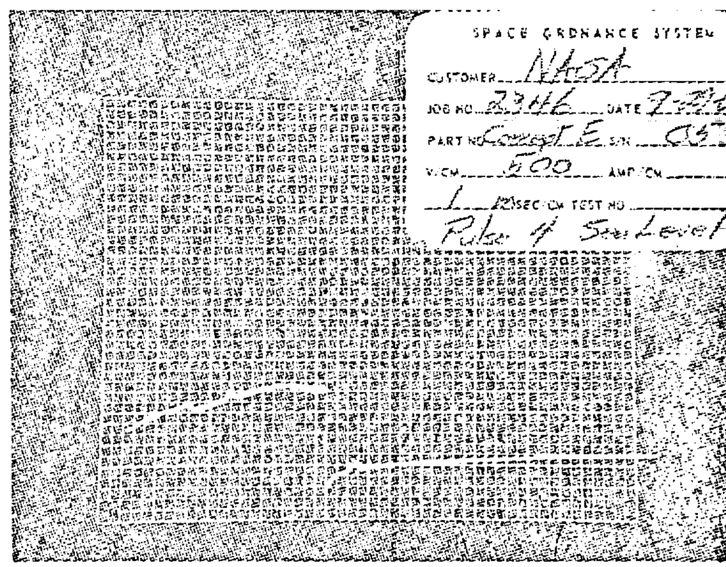
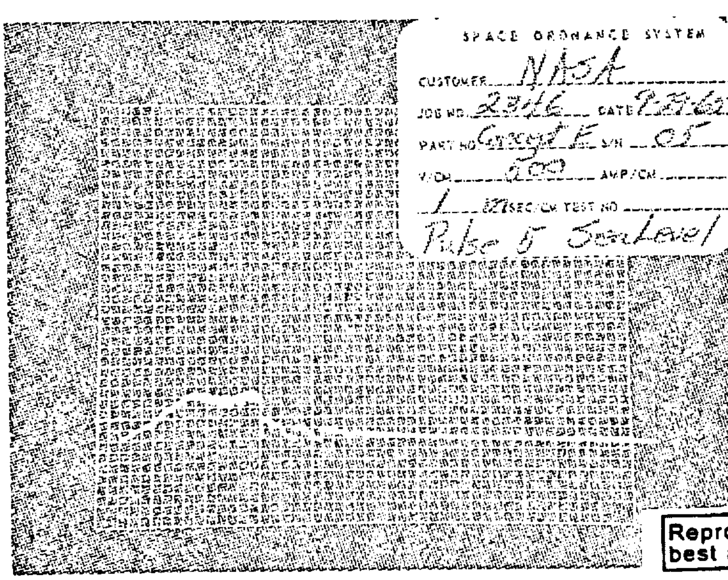
SPACE ORDNANCE SYSTEMS, INC.



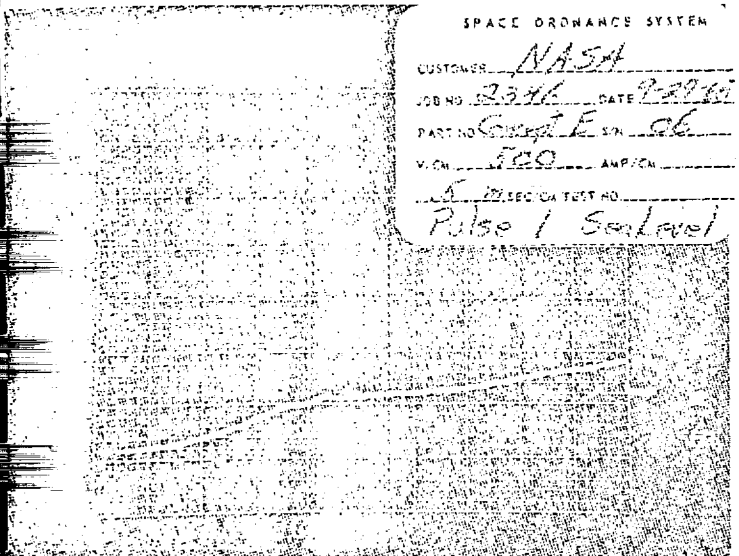


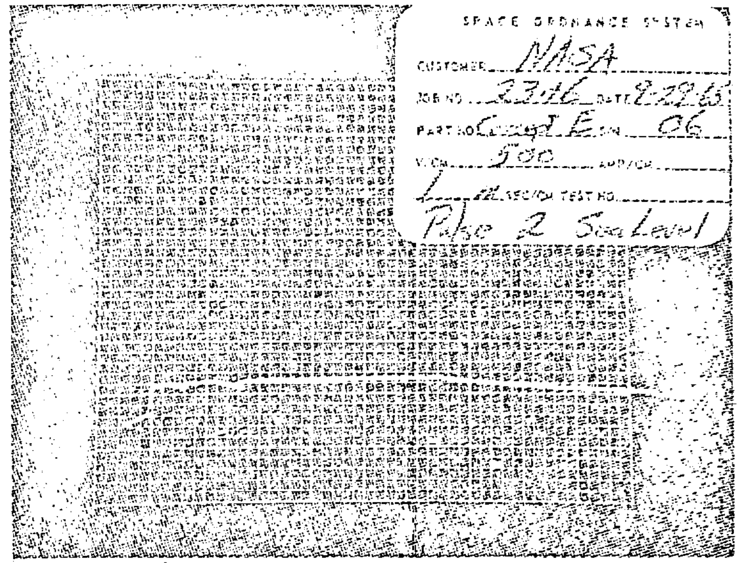


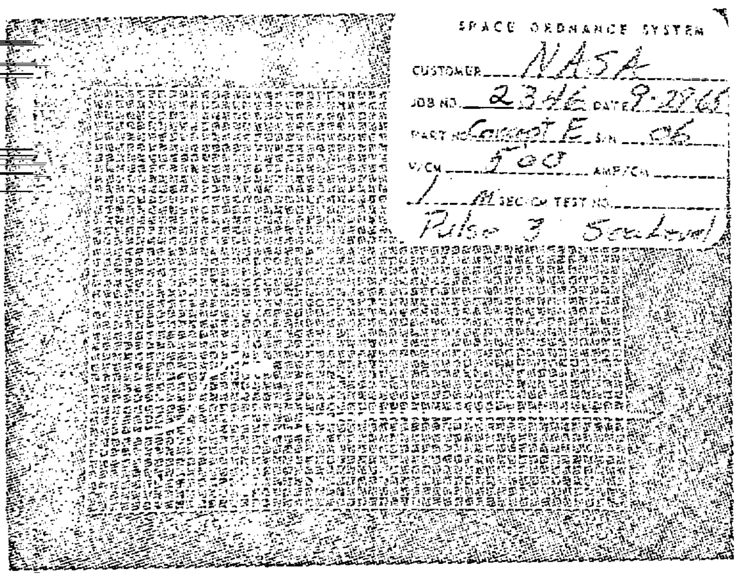


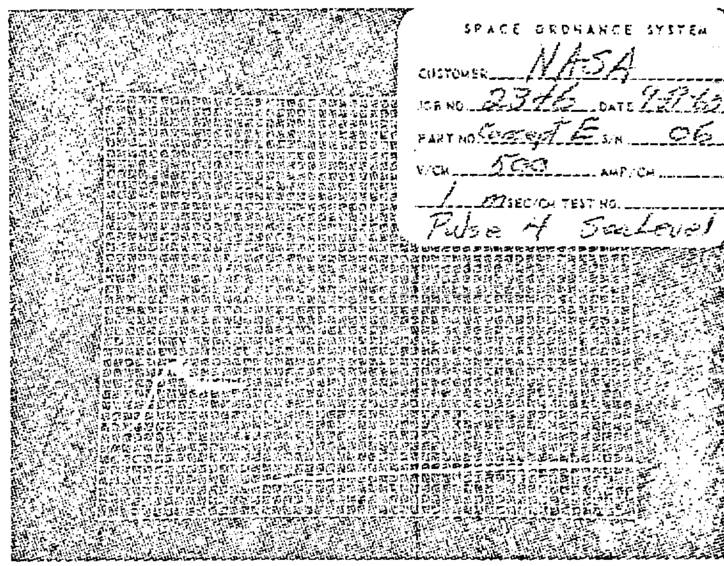


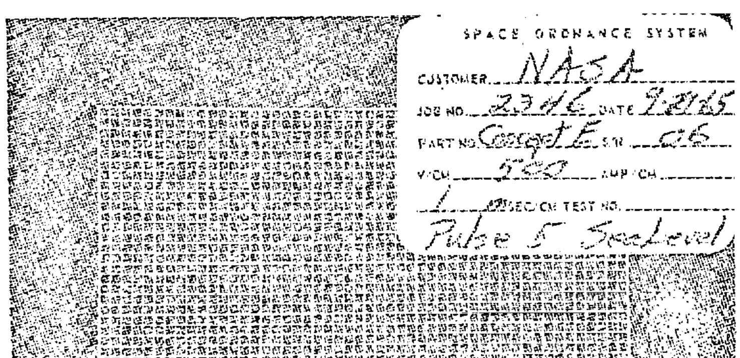
SPACE ORDNANCE SYSTEMS, INC.











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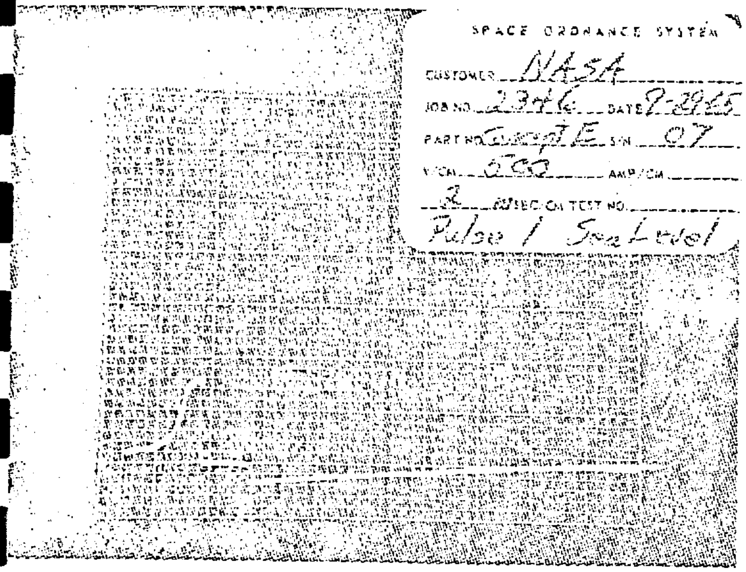
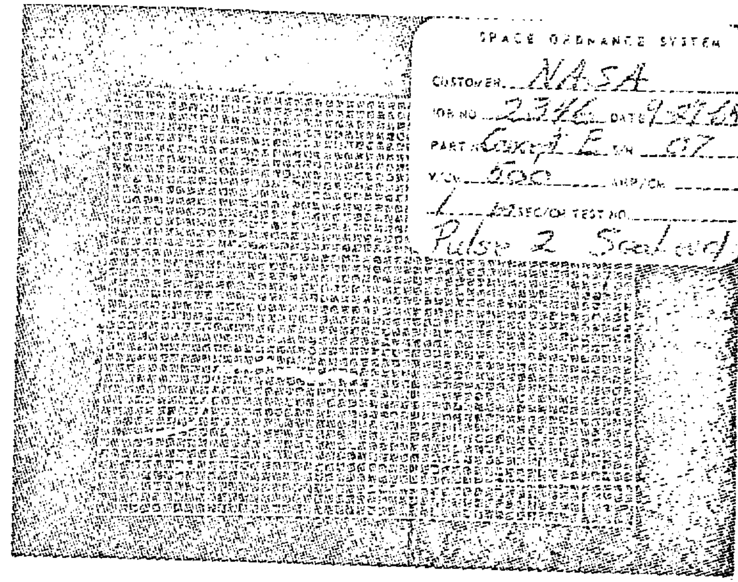
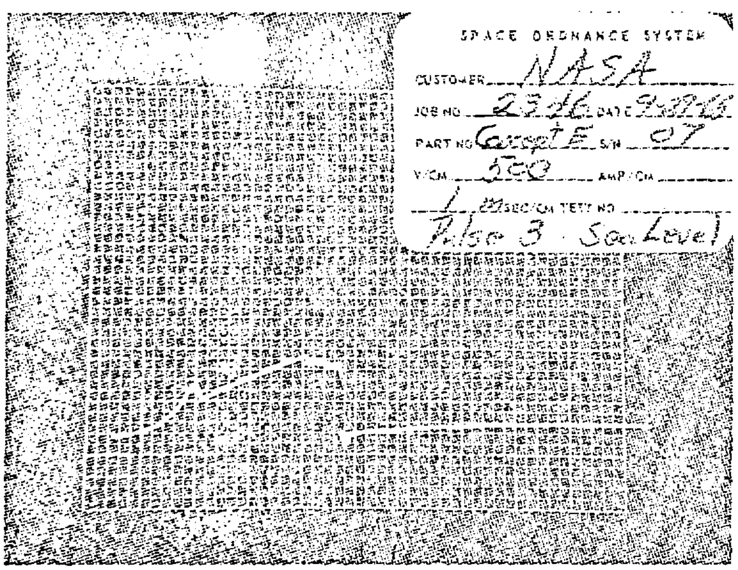
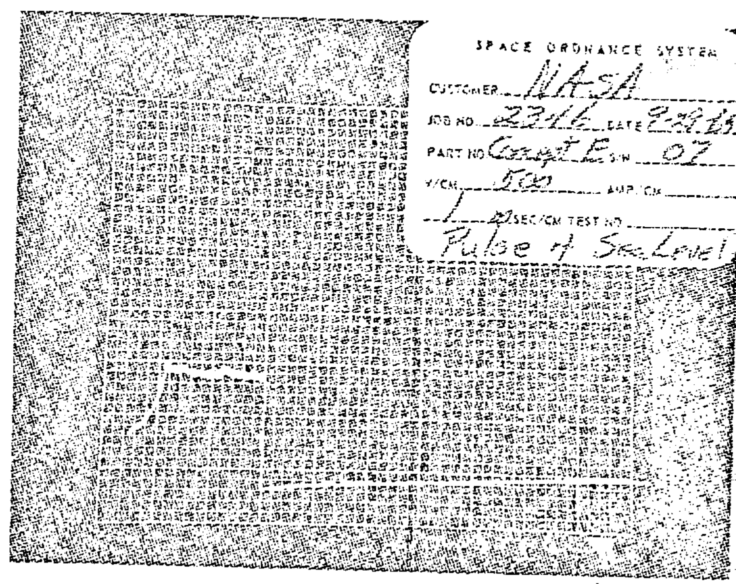
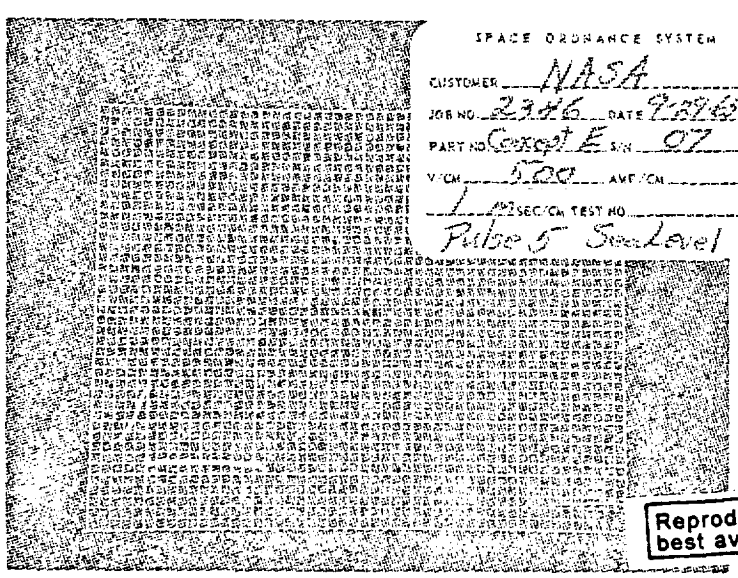
SPACE ORDNANCE SYSTEMS, INC.



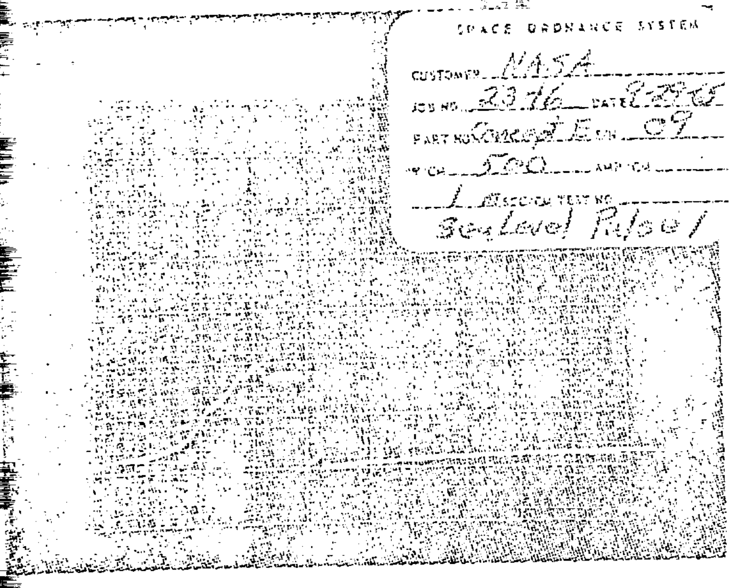


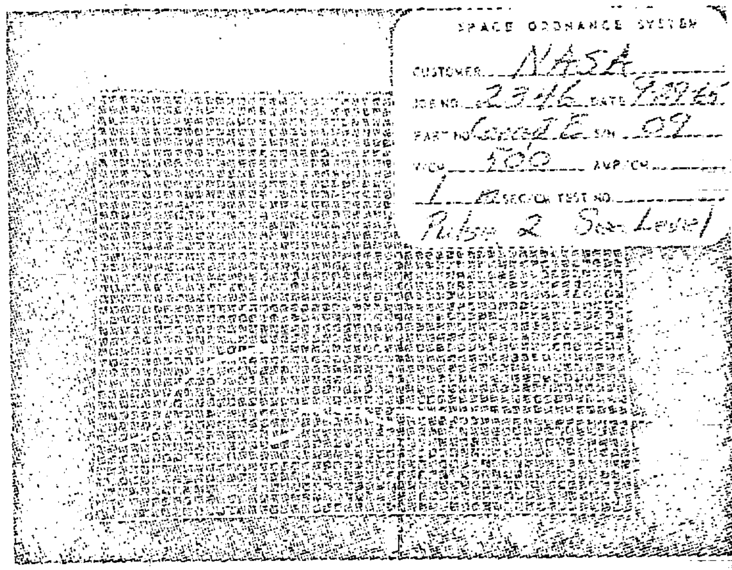


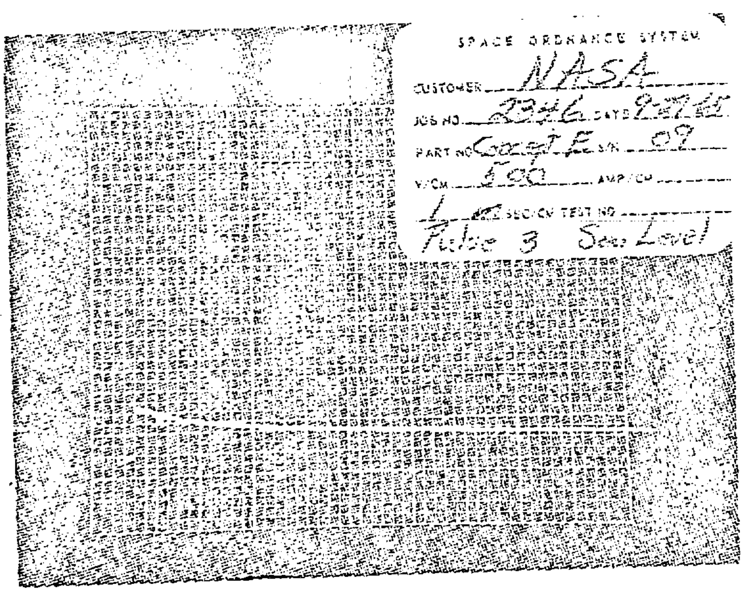


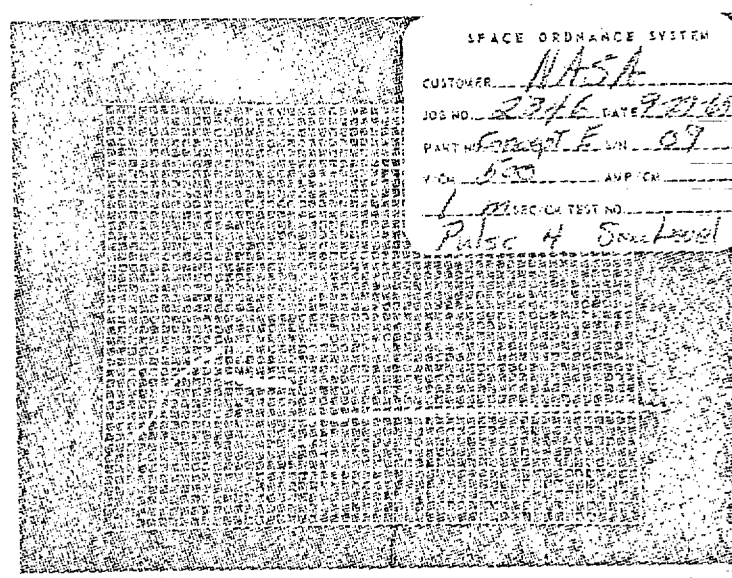


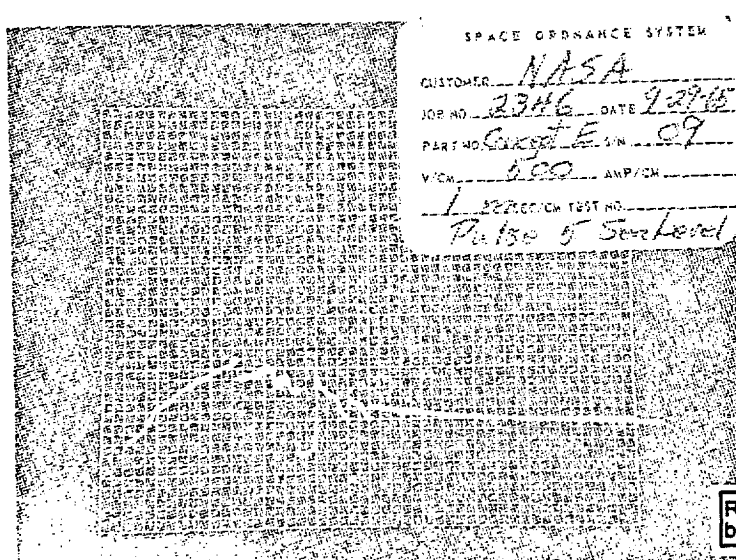
SPACE ORDNANCE SYSTEMS, INC.



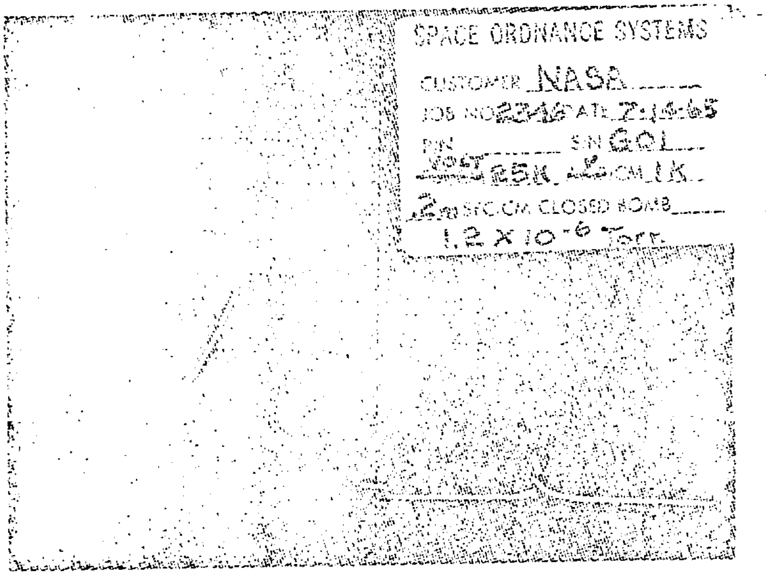


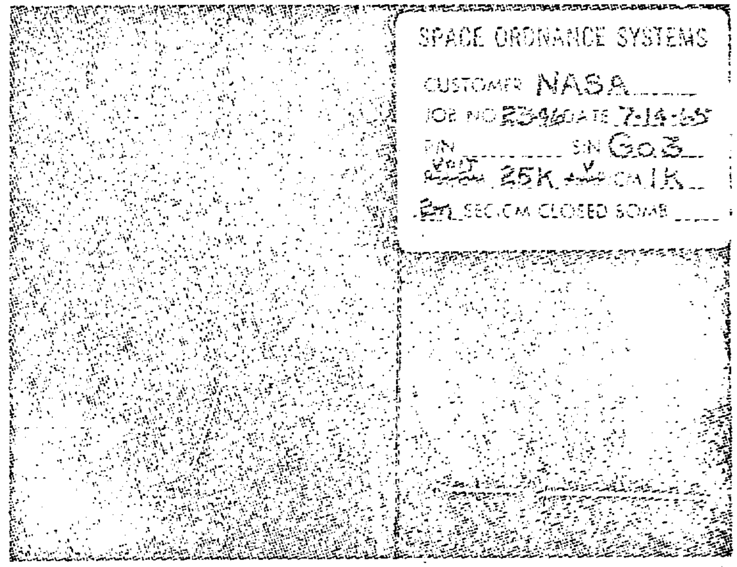


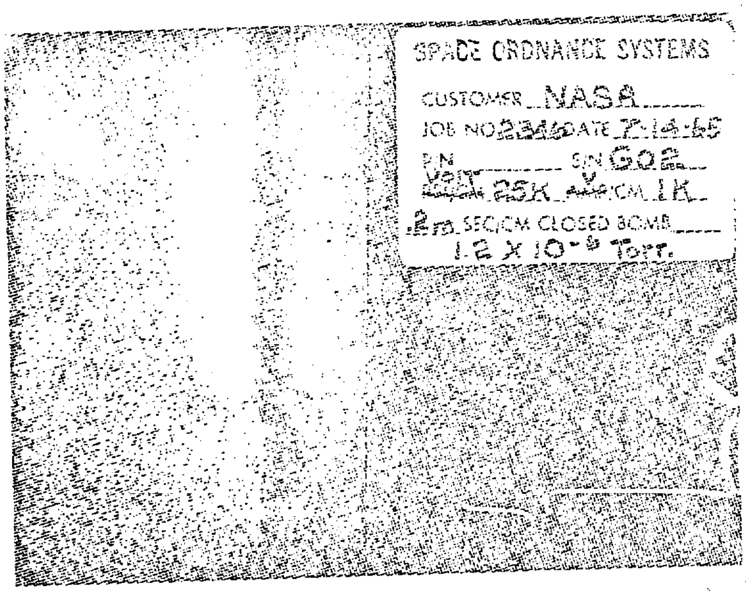




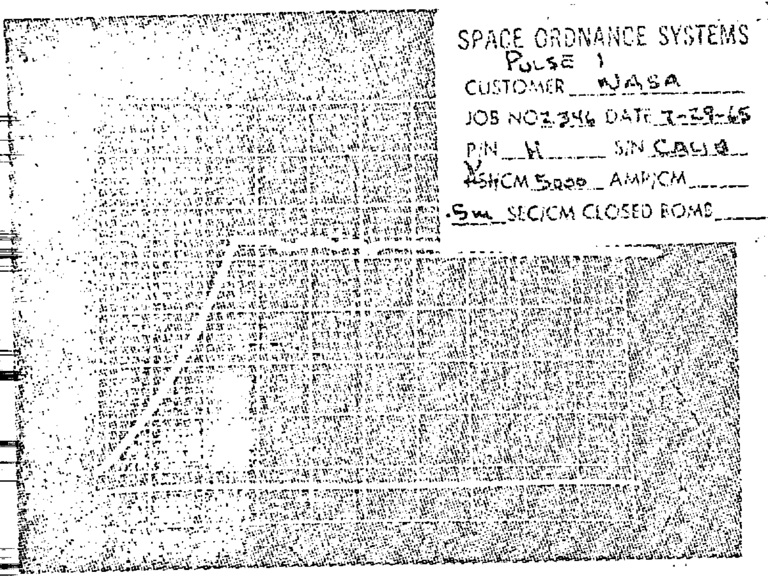
SPACE ORDNANCE SYSTEMS, INC.

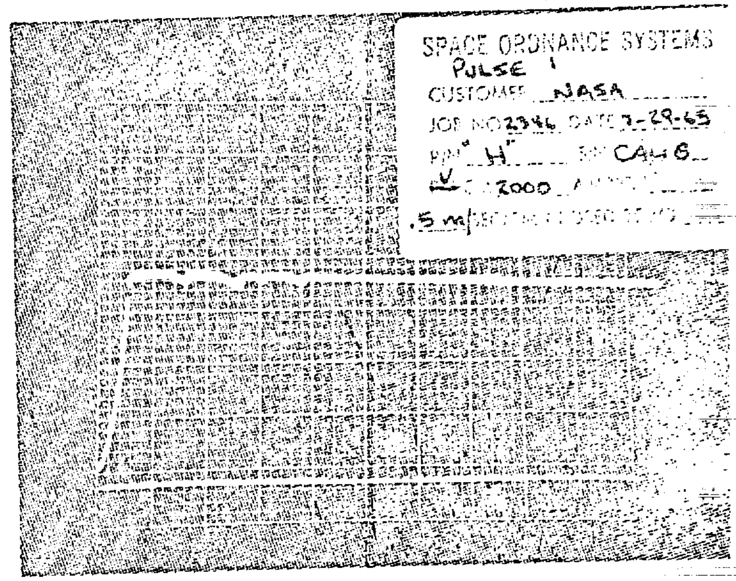


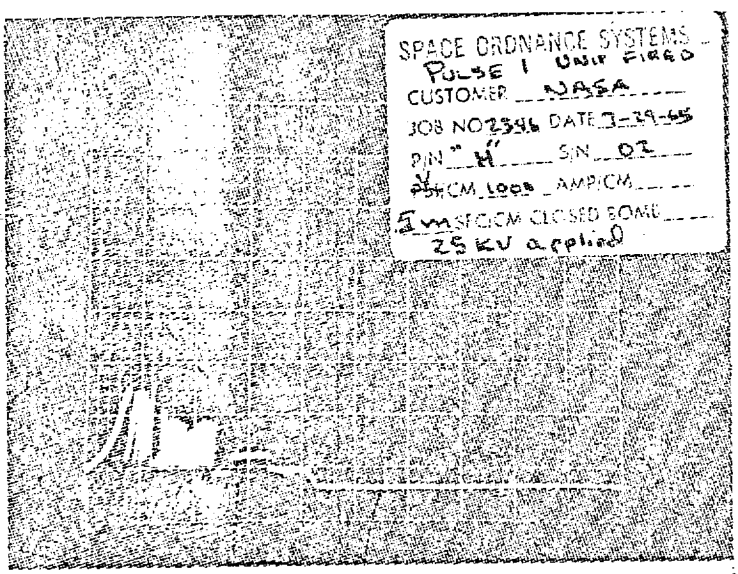


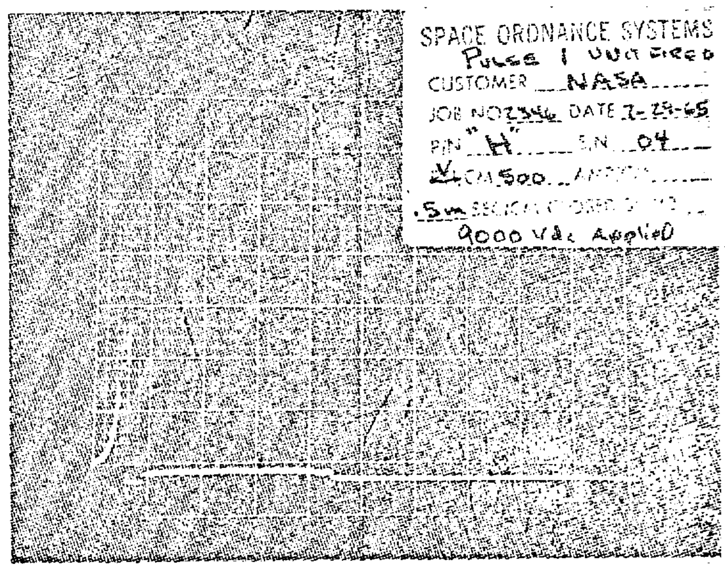


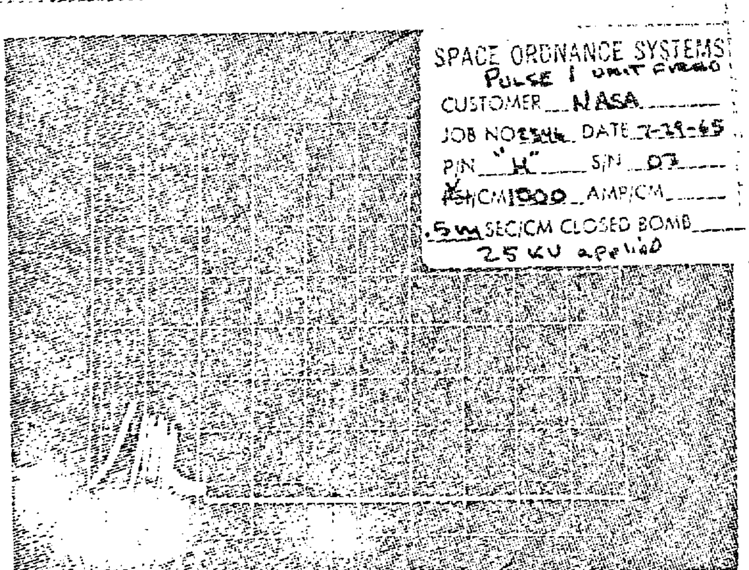
SPACE ORDNANCE SYSTEMS, INC.











SPARK GAP BREAKDOWN TEST DATA

SPACE ORDNANCE SYSTEMS, INC.

DATA SHEET

CUSTOMER NASA

JOB NO. 2346

REPORT NO.

DATE. 7-31-65

PART NO. .030 RADIUS WITH 0.010" GAP

AMBIENT TEMP. 70±10°F

SPEC.

PHOTO.

PARA.

TEST MEDIUM

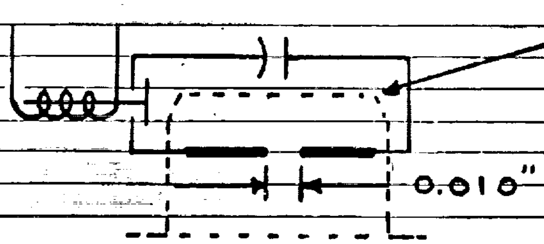
S/N

TEMP.

MANUFACTURER	
INSTRUMENTATION	
S/N	
RANGE	
RATED	
ACCURACY	

ELECTROSTATIC DISCHARGE 500 $\mu\mu f$

PULSE NO	VOLTAGE APPLIED	CONDITION	BREAKDOWN VOLTAGE
1	9000	14.7 PSIA	3,000
2	9000	14.7 PSIA	2,550
3	9000	14.7 PSIA	4,500
4	25,000	14.7 PSIA	3,500
5	25,000	14.7 PSIA	3,000
6	25,000	14.7 PSIA	4,000
1	9,000	1.1×10^{-6} Torr	6,300
2	9,000	1.1×10^{-6} Torr	
3	9,000	1.1×10^{-6} Torr	
4	25,000	1.1×10^{-6} Torr	13,200
5	25,000	1.1×10^{-6} Torr	15,200
6	25,000	1.1×10^{-6} Torr	11,000
7	25,000	1.1×10^{-6} Torr	11,700



SPECIMEN FAILED

TESTED BY W. Dorsey

SPECIMEN PASSED

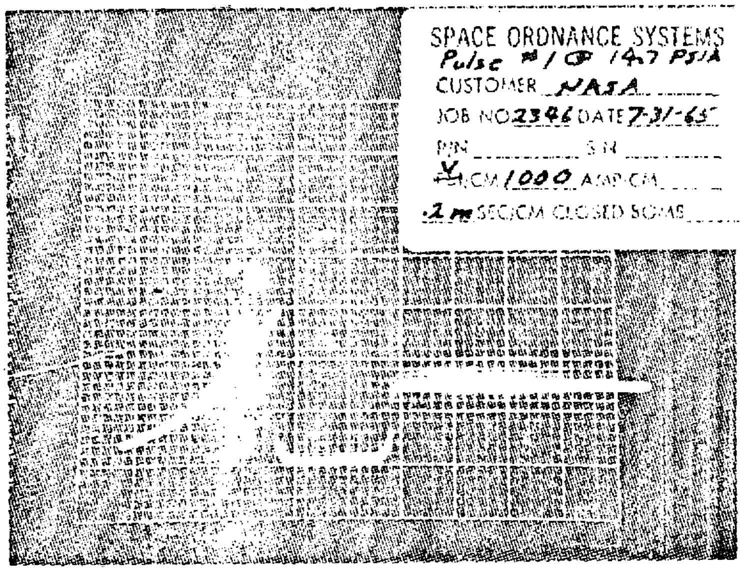
WITNESS

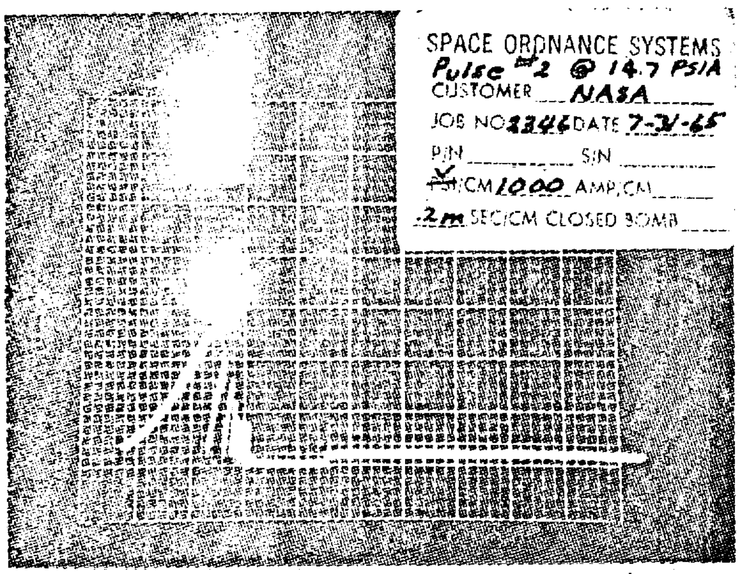
F.R. WRITTEN

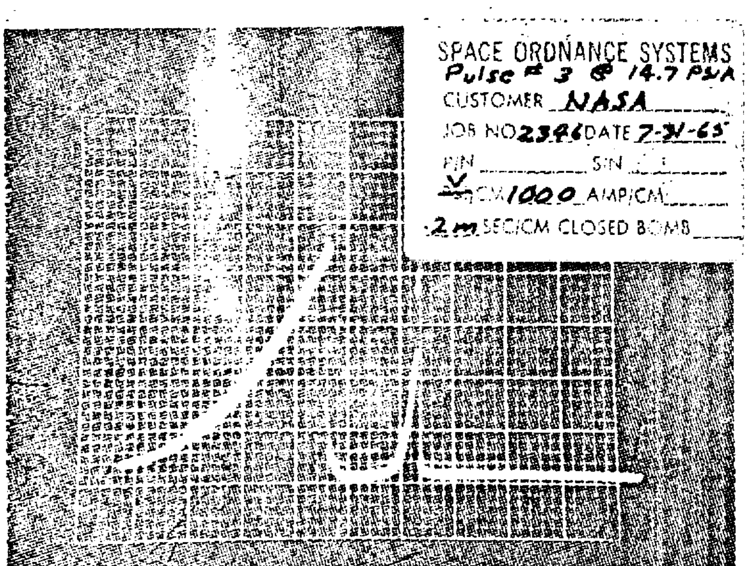
SHEET NO. 83 OF

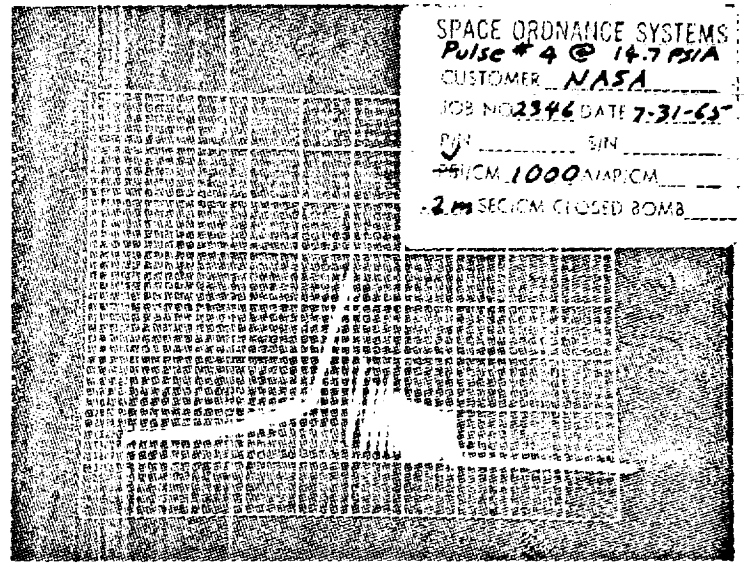
2346
010 gap

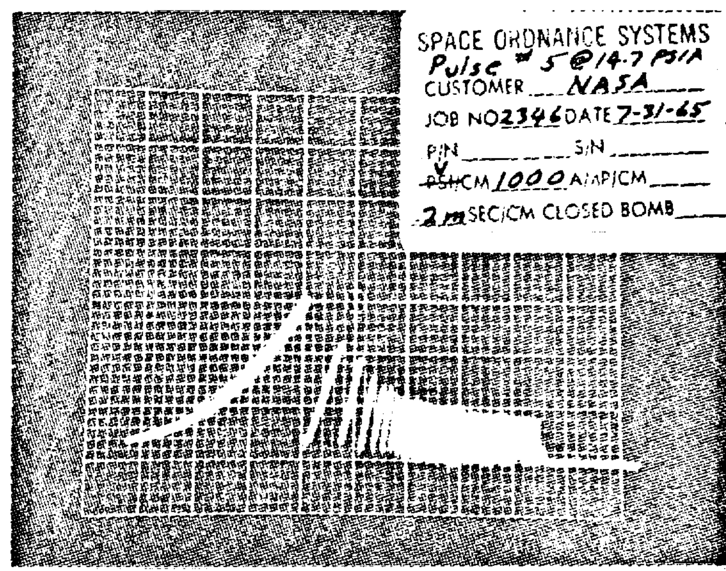
SPACE ORDNANCE SYSTEMS, INC.

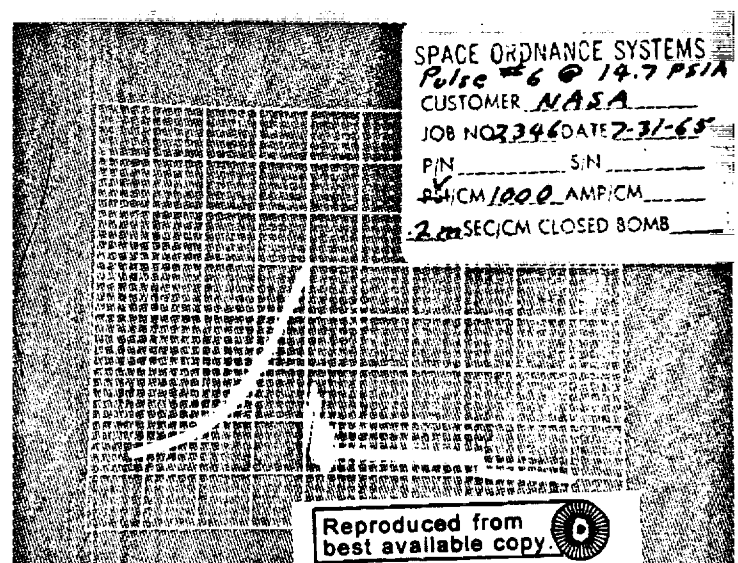




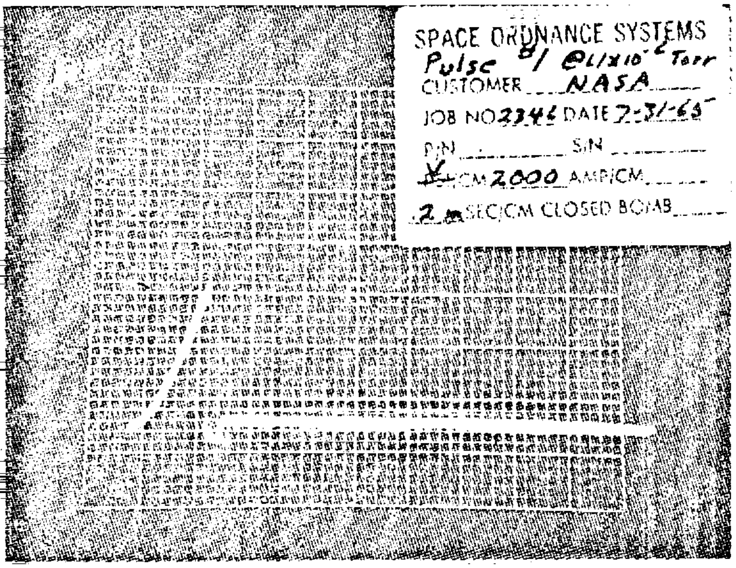


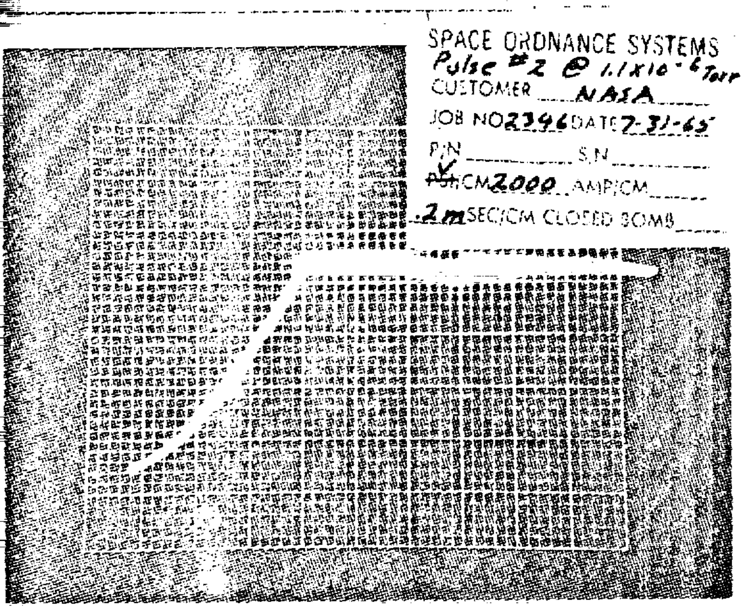


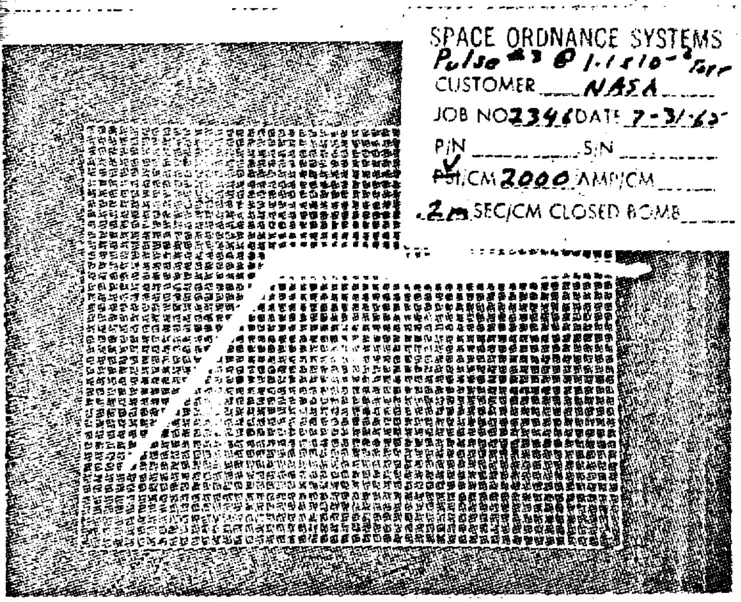


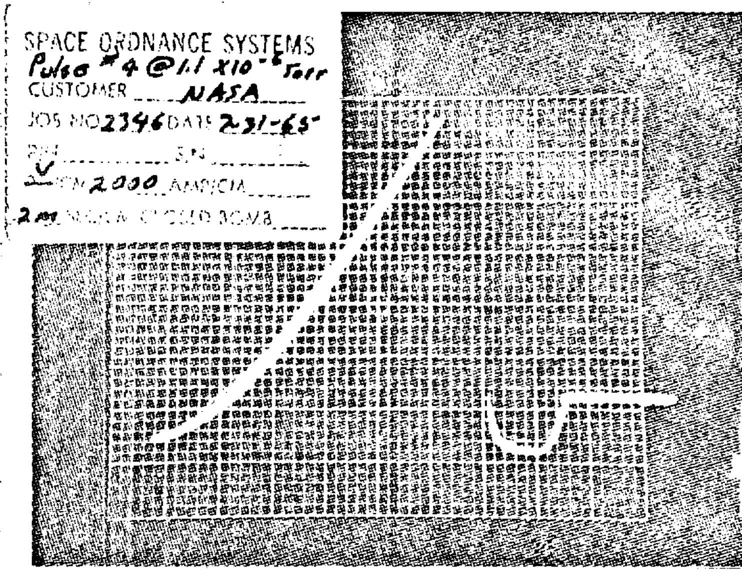


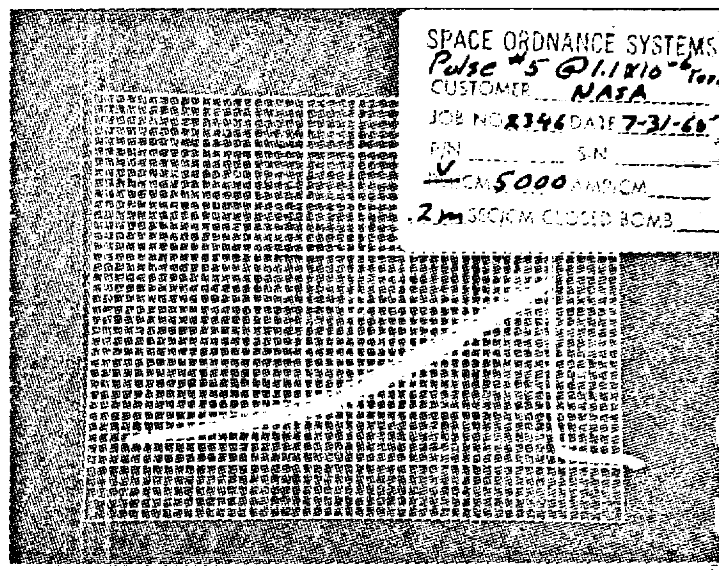
SPACE ORDNANCE SYSTEMS, INC.

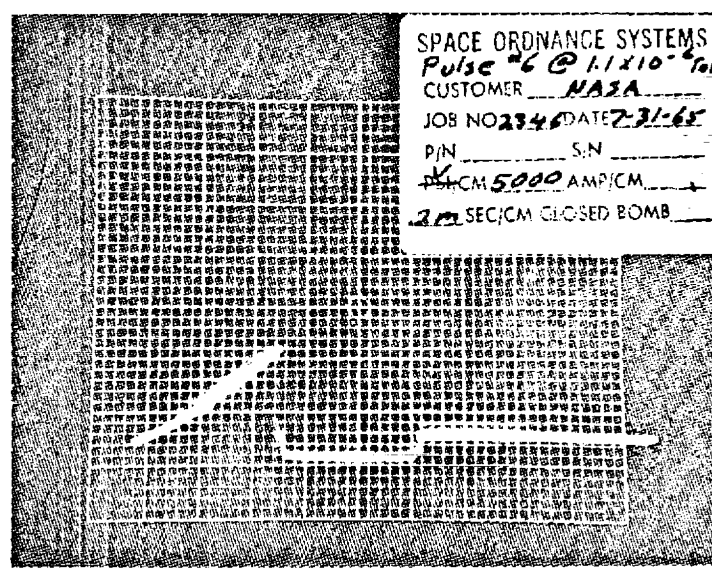




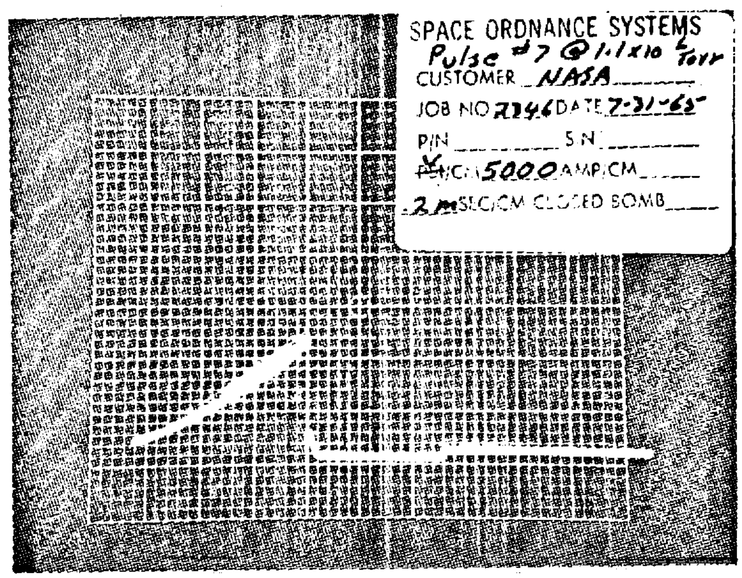








2346
.010" gap


SPACE ORDNANCE SYSTEMS
Pulse #7 @ 1.1x10 Torr
CUSTOMER NASA
JOB NO 2346 DATE 7-31-65
P/N ___ S/N ___
V/CM 5000 AMP/CM
2 m SEC/CM CLOSED BOMB

INITIATION CHARGE PELLET TEST DATA

SPACE ORDNANCE SYSTEMS, INC.

DATA SHEET

CUSTOMER: NASA

JOB NO. 2346

REPORT NO.

PART NO. INITIATION CHARGE (780 LB COMPRESSION)

DATE: 8-6-65

SPEC. VERBAL INSTRUCTIONS

AMBIENT TEMP. 70° ± 15° F

PARA.

PHOTO.

S/N

TEST MEDIUM /

TEMP. AMBIENT

MANUFACTURER	
INSTRUMENTATION	
S/N	
RANGE	
RATED	
ACCURACY	

DC VOLTS APPLIED	CURRENT PASSED MICROAMPS	EQUIVALENT RESISTANCE OHMS	REMARKS
BEFORE DIELECTRIC BREAKDOWN			
5.0	<1.0	—	
10.0	1.8	5.56 MEG	
15.0	3.0	5.00 "	
20.0	3.8	5.27 "	
25.0	4.8	5.20 "	
30.0	6.0	5.00 "	
35.0	6.8	5.15 "	
40.0	7.8	5.13 "	
45.0	8.6	5.23 "	
50.0	9.7	5.15 "	
55.0	10.5	5.23 "	
60.0	11.5	5.21	
AFTER BREAKDOWN @ 160 VAC			
0.1	1.8	55.5 K	
0.5	5.0	100.0 K	
1.0	10.0	100.0 K	
1.5	15.0	100.0 K	
2.0	21.0	95.3 K	
3.0	37.0	81.0 K	
4.0	52.0	77.0 K	
5.0	61.0	82.0 K	
6.0	76.0	79.0 K	
8.0	110.0	72.6 K	
10.0	147.0	68.0 K	
20.0	340.0	60.7 K	
30.0	370.0		OSCILLATING - TEST LEADS MOVED - HAD READ AS HIGH AS 700 μa
40.0	380.0		
50.0	550.0		
VOLTAGE DROPPED TO ZERO			
50.0	400.0		

VOLTAGE DROPPED TO ZERO - AFTER APPROX 1 HR. SHUTDOWN SEVERAL POINTS WERE RECHECKED & FOUND TO BE APPROXIMATELY THE SAME AS THE PRE-BREAKDOWN READINGS.

SPECIMEN FAILED

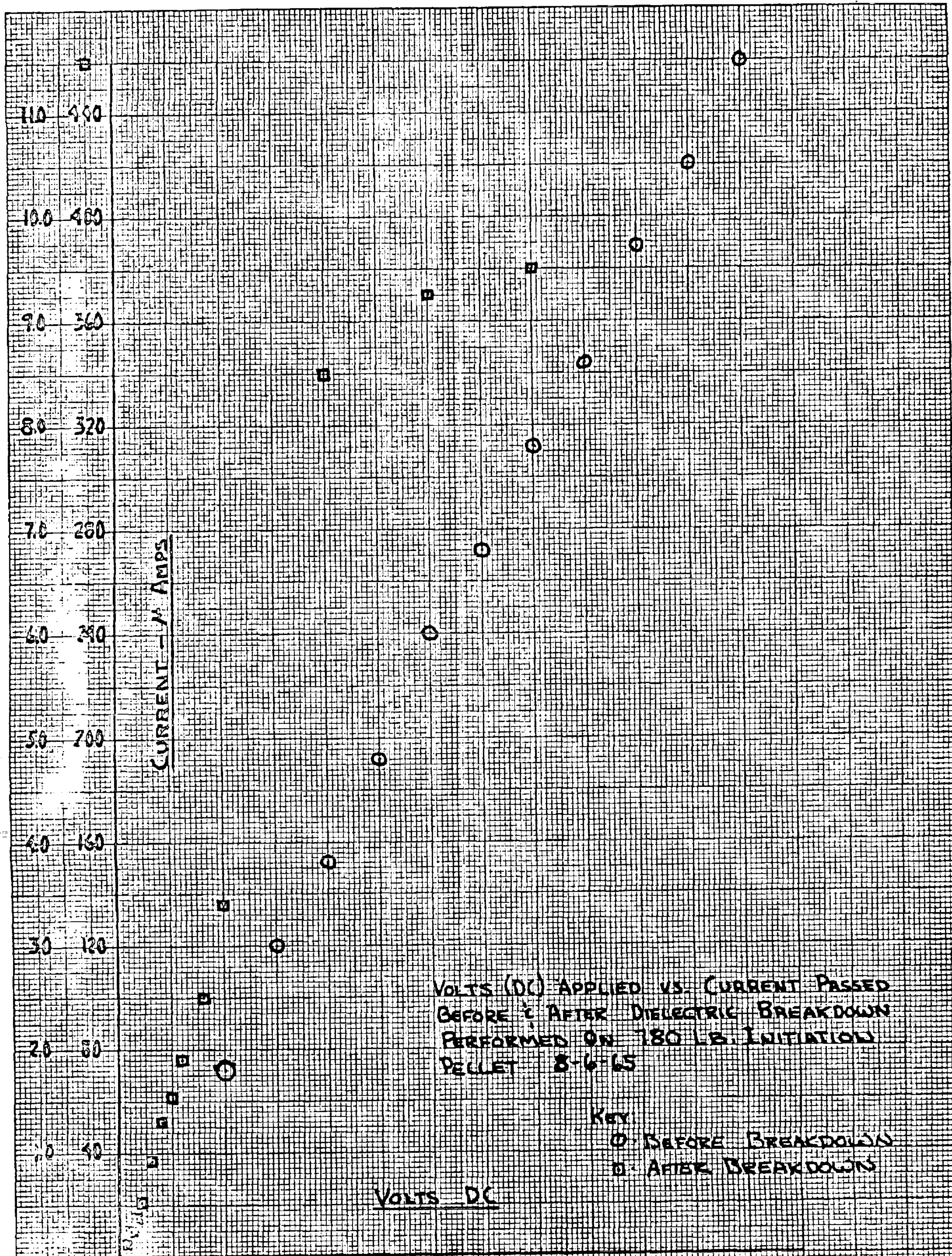
SPECIMEN PASSED

F.R. WRITTEN

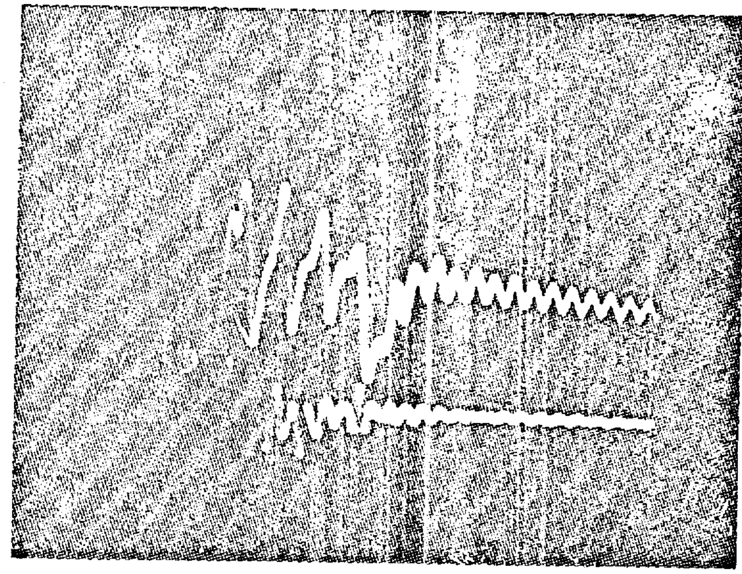
TESTED BY WCD & LMH.

WITNESS

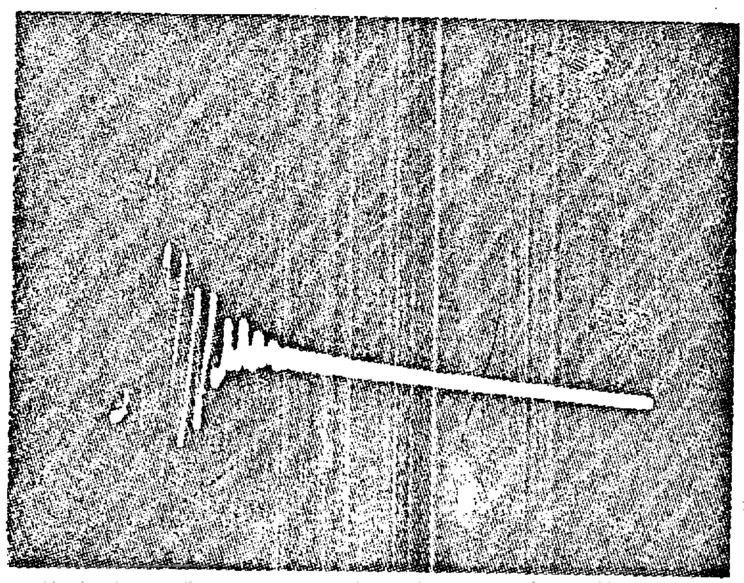
SHEET NO. ____ OF ____



Volts (DC) Applied vs. Current Passed
Before & After Dielectric Breakdown
Performed on 180 Lb. Initiation
Pellet 8-6-65
Key:
O - Before Breakdown
□ - After Breakdown
Current — μ Amps
Volts DC
11.0 440
10.0 400
9.0 360
8.0 320
7.0 280
6.0 240
5.0 200
4.0 160
3.0 120
2.0 80
1.0 40
0
10
20
30
40
50
60



100 V/CM
.2 μ SEC/CM
9000 V APPLIED
550 V BREAKDOWN



100 V/CM
.5 μ SEC/CM
500 V BREAKDOWN.

INTERNAL PULSE PROTECTION DATA

P.O. NO. ____________

CONTR. NO. ____________

SPACE ORDNANCE SYSTEMS, INC.

FINAL ACCEPTANCE TEST DATA SHEET

JOB NO. 2346

SPEC. ____________ ITEM PIN HEADER DWG. NO. ____________ TOTAL ACCEPT ______ REJECT ______

TEST SPEC. ____________ TEST TECH. ____________ APPROVED ____________ DATE ____________

SERIAL NUMBER	PULSE	VOLTAGE LEVEL	INSUL. RES AT 500 VDC MEGOHMS	BRIDGE-WIRE RESISTANCE OHMS A-B	C-D	DIELECTRIC STRENGTH AT 500VAC MICRO AMPS	INTERBRIDGE RESISTANCE CIRCUITS A-B TO C-D	INTER BRIDGE CAPACITANCE AT ONE MEGA-CYCLE CIRCUITS A-B TO C-D	PIN TO CASE CAPACITANCE AT ONE MEGA-CYCLE SHORTED PINS TO CASE	BREAKDOWN VOLTAGE
			70 K	1.069	1.036	4 μa	.058	1.6 Pf	4.4 Pf	
A	1	9000								2800
VARNISH			70 K	1.074	1.039	4 μa	4.457	2.4 Pf	6.0 Pf	
	2	12,000								3300
			120 K	1.080	1.040	4 μa	4.48	2.2 Pf	6.4 Pf	
	3	15,000								3600
			14 K	1.075	1.039	6 μa	4.439	2.8 Pf	6.5 Pf	
	4	20,000								2000
			2.5 K	1.070	1.035	4 μa	4.442	2.9 Pf	6.7 Pf	
	5	25000								2900
			40 K	1.071	1.034	4 μa	4.408	2.6 Pf	6.5 Pf	
			200 K	1.077	1.092	4 μa	4.330	1.8 Pf	4.4 Pf	
A1	1	9000								1300
.002 THK			20 K	1.077	1.083	3 μa	.057	1.8 Pf	4.7 Pf	
MYLAR	2	12000								1880
			38 K	1.071	1.077	4 μa	.060	1.8 Pf	4.5 Pf	
	3	15000								1350
			9.5 K	1.076	1.063	5 μa	.059	1.7 Pf	4.8 Pf	
	4	20000								1900
			3 K	1.069	1.058	3 μa	.057	1.8 Pf	4.9 Pf	
	5	25000								1750
			150 K	1.071	1.064	3 μa	.053	1.8 Pf	4.7 Pf	
			120 K	1.110	1.052	—	.054	1.7 Pf	4.6 Pf	
B1	1	9000								3000
.003 THK			300 K	1.109	1.052	2.5 μa	.054	1.8 Pf	4.8 Pf	
MYLAR	2	12000								2400
			28 K	1.111	1.053	3 μa	.058	1.8 Pf	4.6 Pf	
	3	15000								2900
			18 K	1.109	1.047	5 μa	.060	1.7 Pf	4.7 Pf	
	4	20000								3150
			9 K	1.105	1.036	3.5 μa	.058	1.8 Pf	4.8 Pf	
	5	25000								2700
			100 K	1.106	1.040	2.5 μa	.055	1.7 Pf	4.7 Pf	
			300 K	1.026	1.159	2 μa	.068	1.7 Pf	4.5 Pf	
C1	1	9000								4000
.005 THK			50 K	1.027	1.143	3 μa	.060	1.8 Pf	4.9 Pf	
MYLAR	2	12000								2050
			22 K	1.023	1.141	4 μa	.060	1.8 Pf	4.9 Pf	
	3	15000								2900
			3 K	1.023	1.139	6 μa	.060	1.8 Pf	5.2 Pf	
	4	20000								2900
			2.5 K	1.022	1.138	3 μa	.059	1.7 Pf	5.3 Pf	
	5	25000								[illegible]
			45 K	1.025	1.142	4 μa	.052	2.0 Pf	5.3 Pf	

P.O. NO. ______________

CONTR. NO. ______________

SPACE ORDNANCE SYSTEMS, INC.

FINAL ACCEPTANCE TEST DATA SHEET

JOB NO. 2346

SPEC. VARNISH ITEM PIN HEADER DWG. NO. ______ TOTAL ACCEPT ______ REJECT ______

TEST SPEC. ______ TEST TECH. ______ APPROVED ______ DATE ______

SERIAL NUMBER	PULSE	VOLTAGE LEVEL	INSUL RES AT 500 VDC MEGOHMS	BRIDGE-WIRE RESISTANCE A-B	BRIDGE-WIRE RESISTANCE C-D	DIELECTRIC STRENGTH AT 500VAC MICROAMPS	INTERBRIDGE RESISTANCE CIRCUITS A-B TO C-D	INTER BRIDGE CAPACITANCE AT ONE MEGA-CYCLE CIRCUITS A-B TO C-D	PIN TO CASE CAPACITANCE AT ONE MEGA-CYCLE SHORTED PINS TO CASE	BREAKDOWN VOLTAGE
			100 K	.968	.972	4 Ma	.051	1.6 Pf	4.4 Pf	
B	1	25000								3150
			80 K	.973	.969	4.0 Ma	4.405	2.3 Pf	5.6 Pf	
			240 K	1.062	1.066	4 Ma	.050	1.7 Pf	4.4 Pf	
C	1	25000								3700
			300 K	1.066	1.052	4 Ma	4.412	2.0 Pf	5.6 Pf	
			70 K	1.092	1.134	3 Ma	.053	1.5 Pf	4.4 Pf	
D	1	25000								3200
			140 K	1.087	1.134	3 Ma	.068	1.9 Pf	5.4 Pf	
			30 K	.981	1.041	4 Ma	.054	1.6 Pf	4.4 Pf	
E	1	25000								2200
			900 K	.982	1.043	3.5 Ma	.057	2.0 Pf	5.1 Pf	

P.O. NO. ____

CONTR. NO. ____

SPACE ORDNANCE SYSTEMS, INC.

FINAL ACCEPTANCE TEST DATA SHEET

JOB NO. 2346

SPEC. 002 MYLAR ITEM PIN HEADER DWG. NO. ____ TOTAL ACCEPT ____ REJECT ____

TEST SPEC. ____ TEST TECH. ____ APPROVED ____ DATE ____

SERIAL NUMBER	PULSE	VOLTAGE LEVEL	INSUL RES AT 500 VDC MEGOHMS	BRIDGE-WIRE RESISTANCE A-B	BRIDGE-WIRE RESISTANCE C-D	DIELECTRIC STRENGTH AT 500VAC MICROAMPS	INTERBRIDGE RESISTANCE CIRCUITS A-B TO C-D	INTER BRIDGE CAPACITANCE AT ONE MEGA-CYCLE CIRCUITS A-B TO C-D	PIN TO CASE CAPACITANCE AT ONE MEGA-CYCLE SHORTED PINS TO CASE	BREAKDOWN VOLTAGE
			40 K	1.085	.985	4 μa	.050	1.8 Pf	4.0 Pf	
A2	1	25,000								1850
			13 K	1.062	.981	2.5 μa	.055	1.6 Pf	4.4 Pf	
			50 K	1.052	1.037	4 μa	.050	1.8 Pf	4.5 Pf	
A3	1	25,000								2300
			21 K	1.054	1.036	3 μa	.055	1.7 Pf	5.0 Pf	
			80 K	1.052	1.050	4 μa	.052	1.8 Pf	4.5 Pf	
A4	1	25,000								2700
			20 K	1.040	1.049	3 μa	.055	1.8 Pf	5.0 Pf	
			300 K	1.068	1.041	4 μa	.054	1.6 Pf	4.4 Pf	
A5	1	25,000								2650
			1000 K	1.069	1.038	3.5 μa	.058	1.7 Pf	4.8 Pf	

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CONTR. NO. ______ FINAL ACCEPTANCE TEST DATA SHEET JOB NO. 2346

SPEC. .003 MYLAR ITEM PIN HEADER DWG. NO. ______ TOTAL ACCEPT ______ REJECT ______

TEST SPEC. ______ TEST TECH. ______ APPROVED ______ DATE ______

SERIAL NUMBER	PULSE	VOLTAGE LEVEL	INSUL RES AT 500 VDC MEGOHMS	BRIDGE-WIRE RESISTANCE A-B	BRIDGE-WIRE RESISTANCE C-D	DIELECTRIC STRENGTH AT 500VAC	INTERBRIDGE RESISTANCE CIRCUITS A-B TO C-D	INTER BRIDGE CAPACITANCE AT ONE MEGA-CYCLE CIRCUITS A-B TO C-D	PIN TO CASE CAPACITANCE AT ONE MEGA CYCLE SHORTED PINS TO CASE	BREAKDOWN VOLTAGE
			300K	1.054	1.074	—	.055	1.7Pf	4.2Pf	
B2	1	25000								900
			∞	1.053	1.070	3.5 μa	.055	1.7Pf	4.8Pf	
			250K	1.103	.992	—	.052	1.7Pf	4.3Pf	
B3	1	25000								2600
			500K	1.099	.987	3.5 μa	.051	1.7Pf	4.7Pf	
			35K	1.067	.951	—	.055	1.7Pf	4.3Pf	
B4	1	25000								2800
			400K	1.034	.942	2.5 μa	.053	1.7Pf	4.7Pf	
			250K	1.057	.979	—	.052	1.7Pf	4.2Pf	
B5	1	25000								2700
			250K	1.049	.976	2.5 μa	.053	1.5Pf	4.5Pf	

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CONTR. NO. ____________ FINAL ACCEPTANCE TEST DATA SHEET JOB NO. 2346

SPEC. .005 MYLAR ITEM PIN HEADER DWG. NO. ________ TOTAL ACCEPT ______ REJECT ______

TEST SPEC. ________ TEST TECH. ________ APPROVED ________ DATE ________

SERIAL NUMBER	PULSE	VOLTAGE LEVEL	INSUL RES AT 500 VDC MEGOHMS	BRIDGE-WIRE RESISTANCE A-B	BRIDGE-WIRE RESISTANCE C-D	DIELECTRIC STRENGTH AT 500VAC MICROAMPS	INTERBRIDGE RESISTANCE CIRCUITS A-B TO C-D	INTER BRIDGE CAPACITANCE AT ONE MEGA-CYCLE CIRCUITS A-B TO C-D	PIN TO CASE CAPACITANCE AT ONE MEGA-CYCLE SHORTED PINS TO CASE	BREAKDOWN VOLTAGE
			50K	1.044	1.050	4 μa	.050	1.7Pf	5.2Pf	
C2	1	25000								2300
			5K	1.044	1.043	3 μa	.055	1.7Pf	4.6Pf	
			300K	1.010	1.018	4 μa	.047	1.7Pf	5.2Pf	
C3	1	25000								2400
			150K	1.007	1.018	3 μa	.052	1.7Pf	4.6Pf	
			30K	1.118	.957	2 μa	.055	1.7Pf	4.6Pf	
C4	1	25000								2900
			150K	1.152	.955	3 μa	.053	1.6Pf	4.5Pf	
			20K	1.041	1.086	4	.056	1.7Pf	4.2Pf	
C5	1	25000								3300
			300K	1.034	1.080	4 μa	.056	1.8Pf	5.1Pf	

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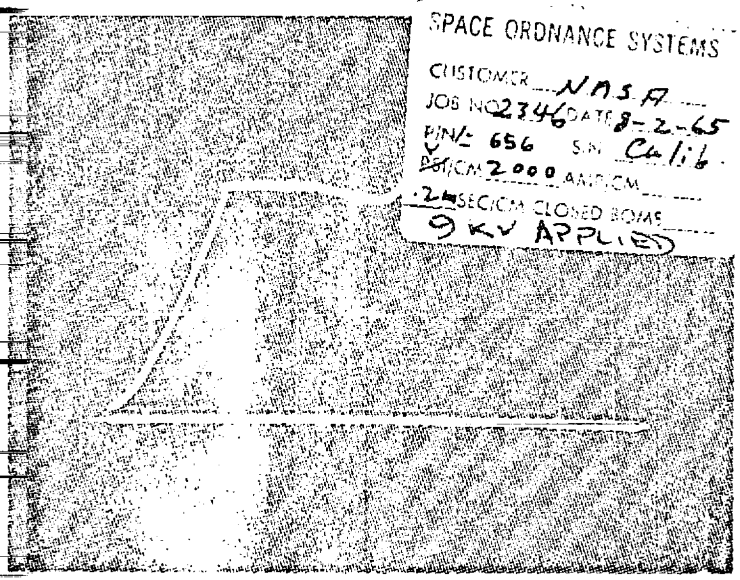

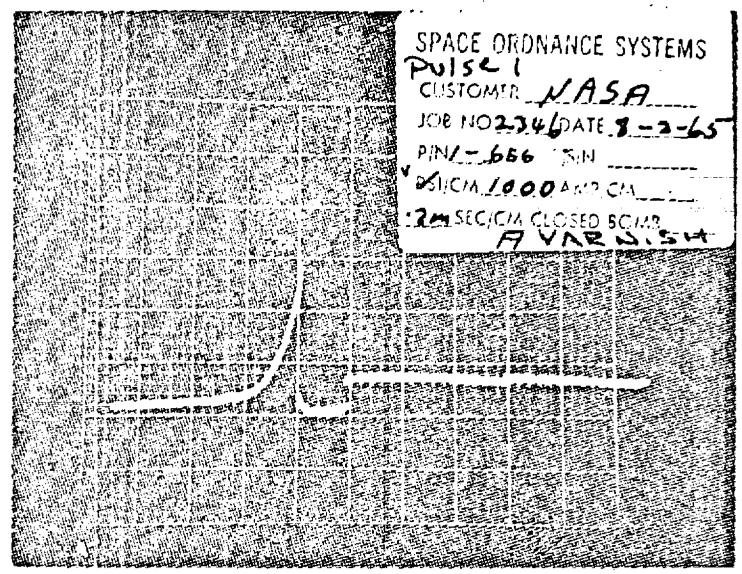

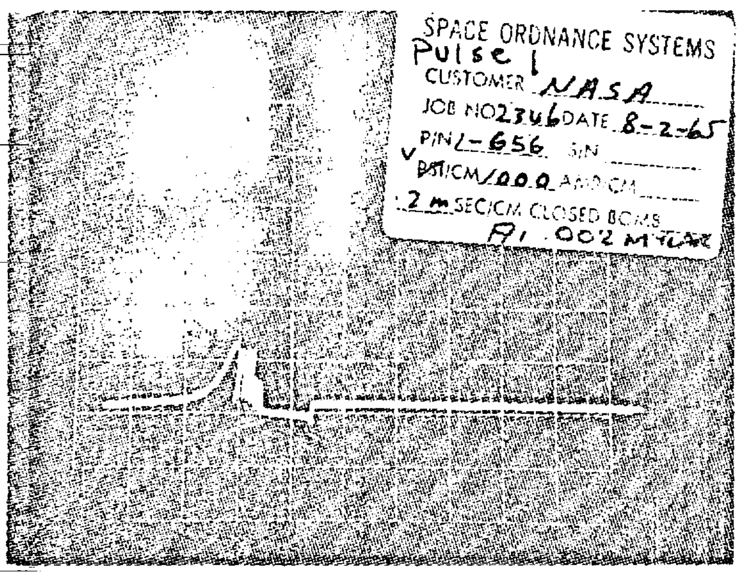

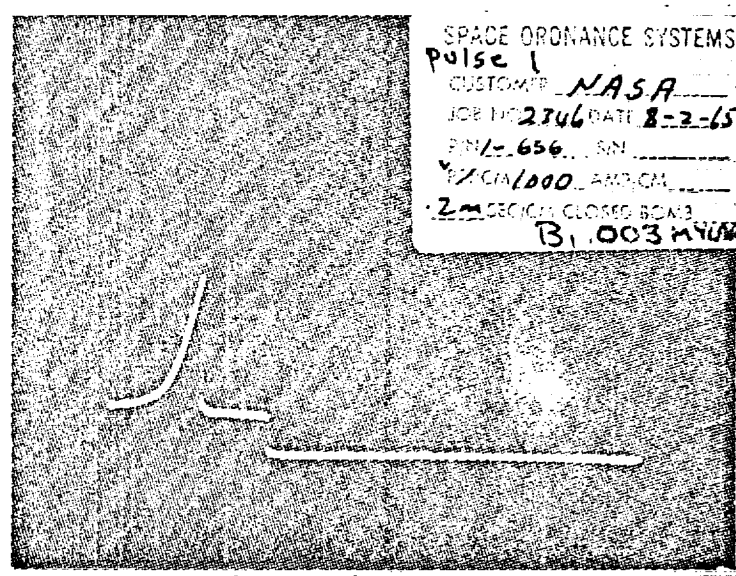

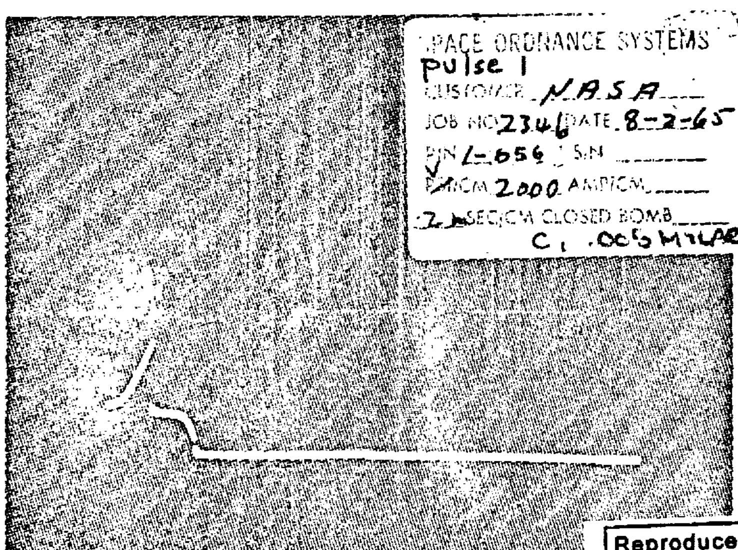

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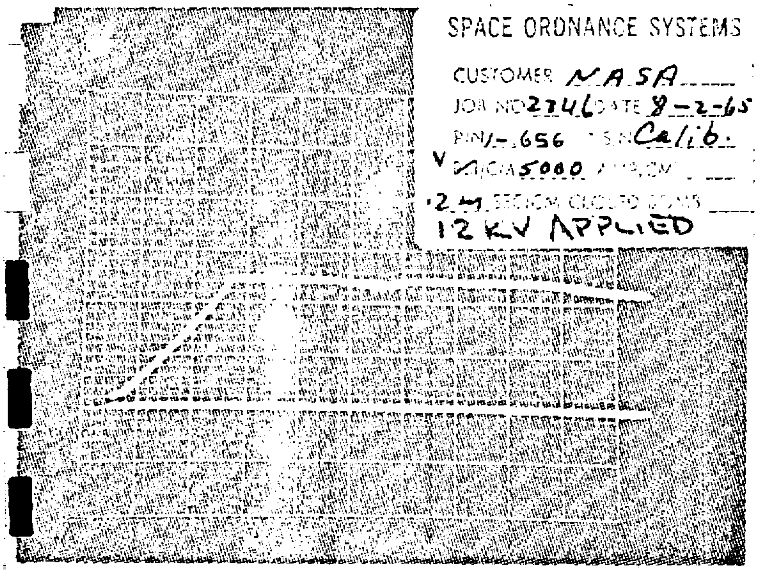

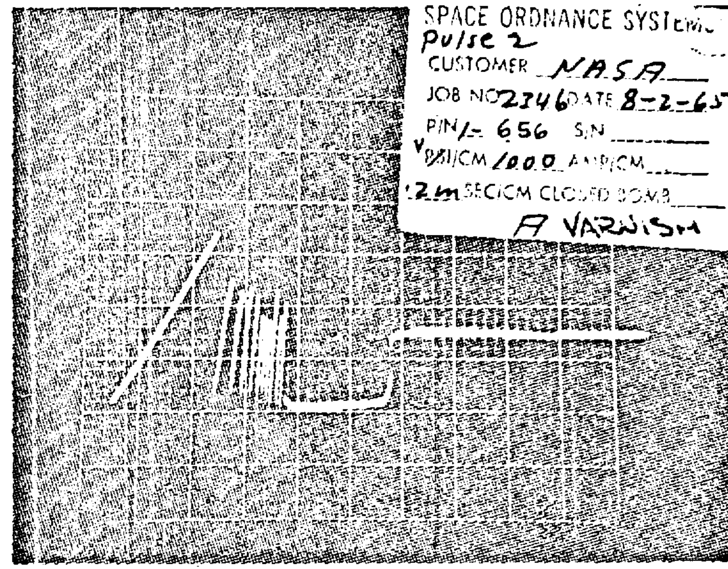

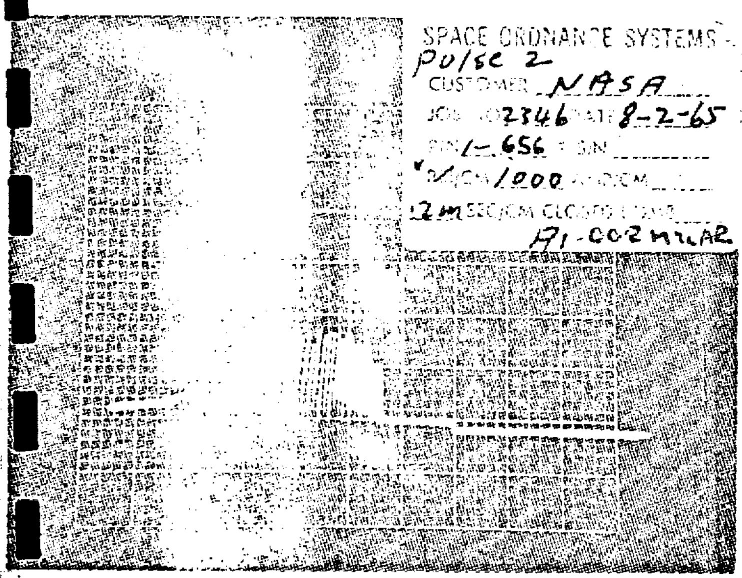

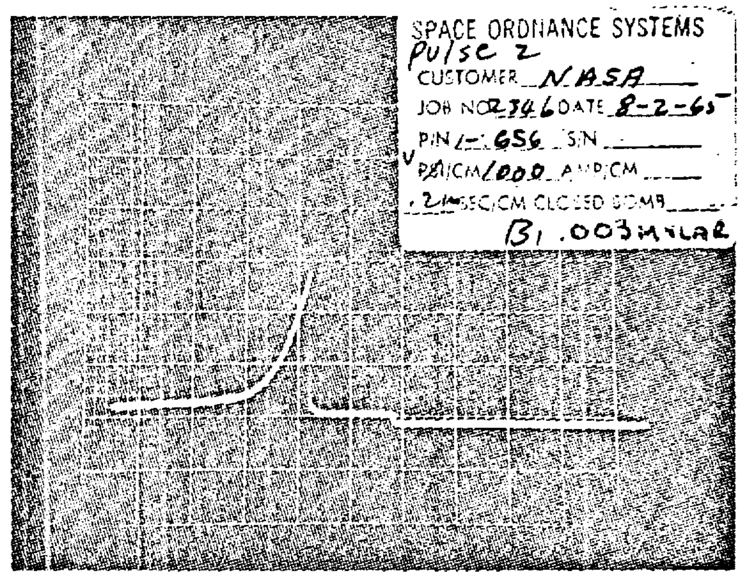

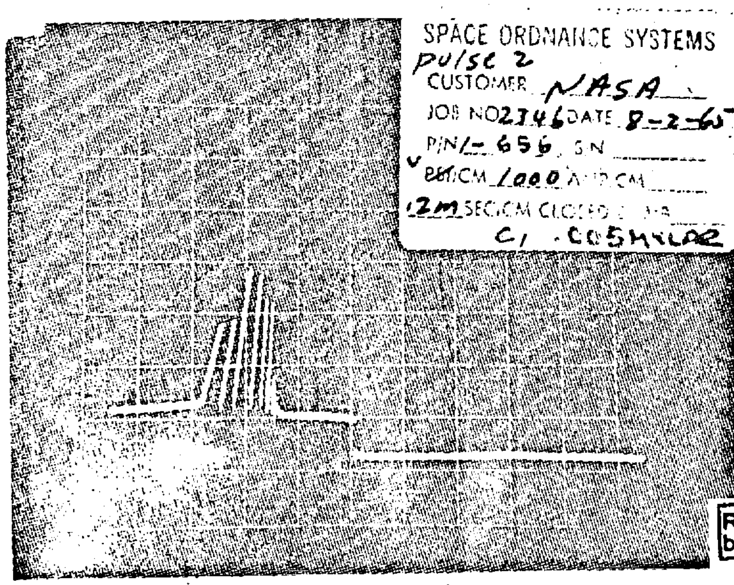

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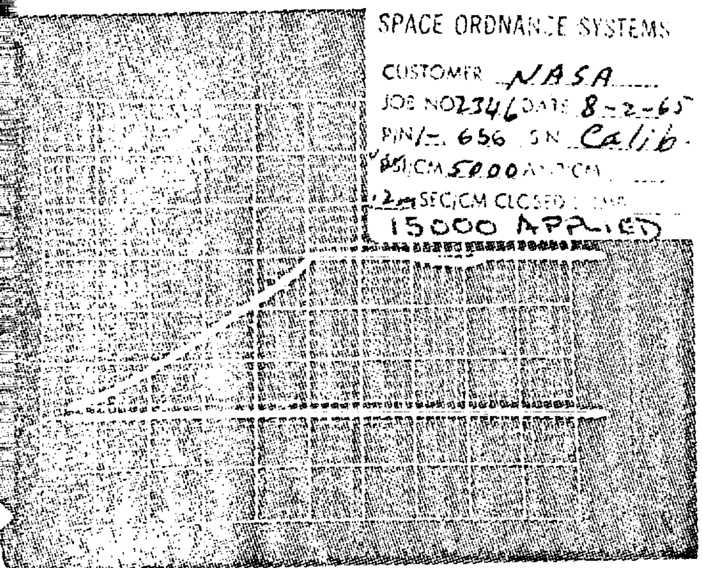

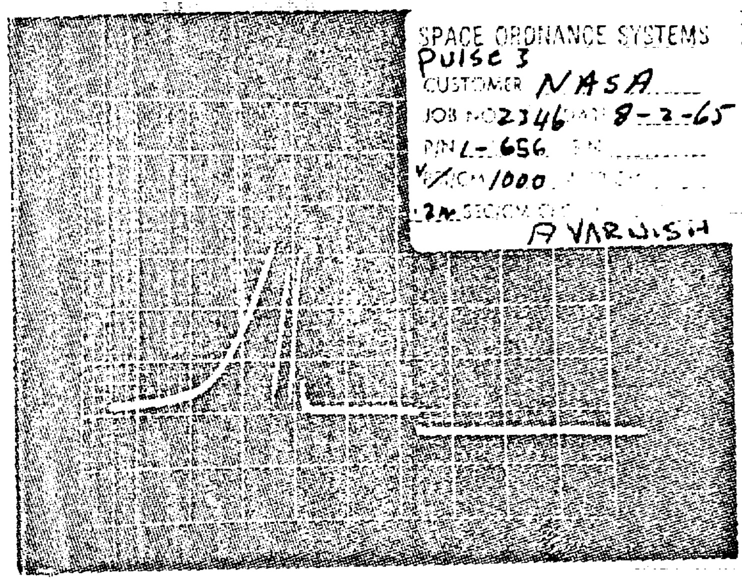

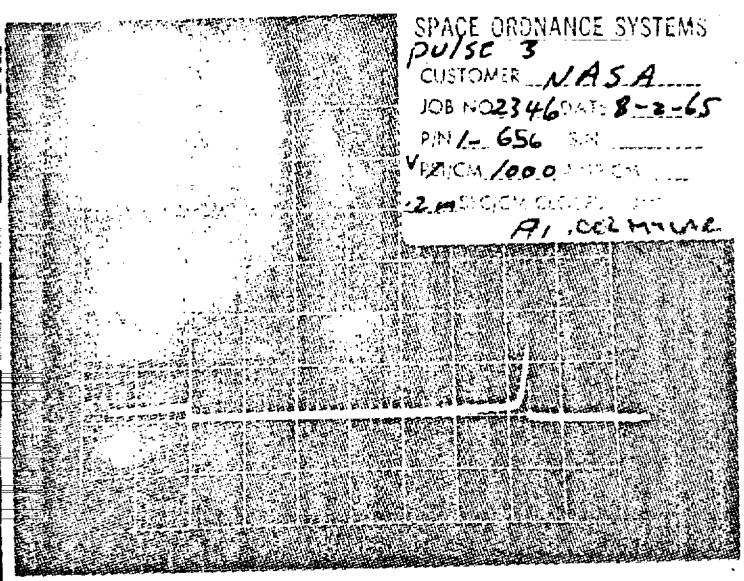

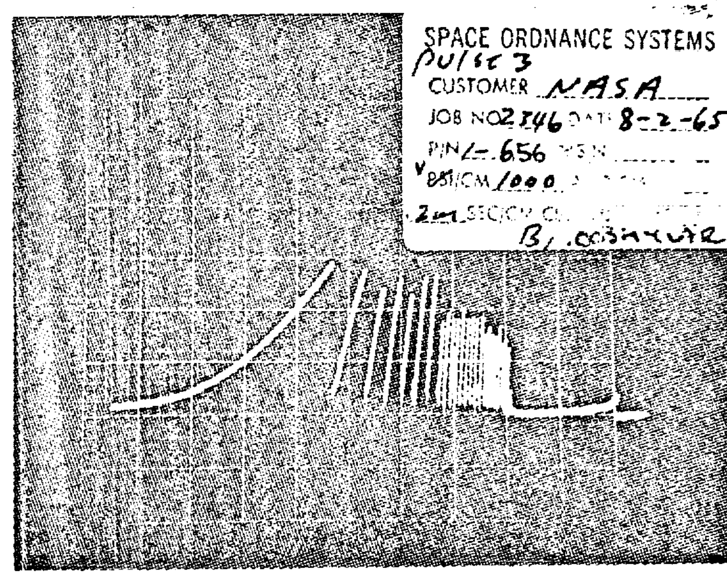

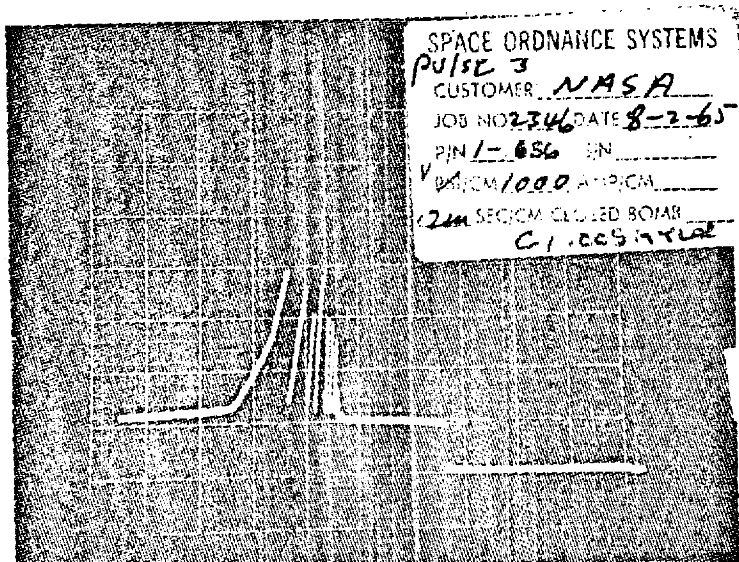

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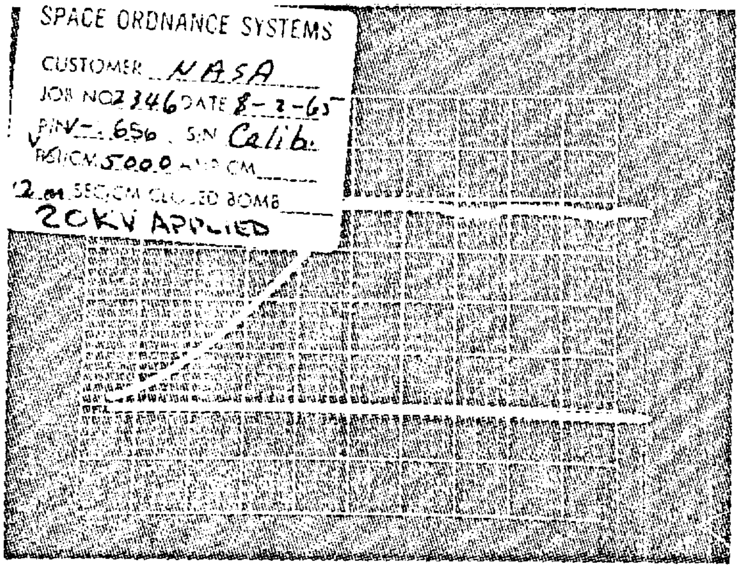

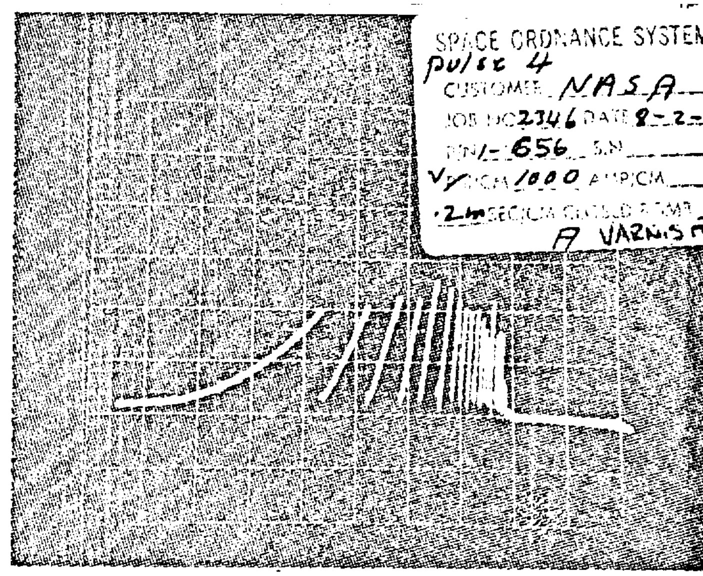

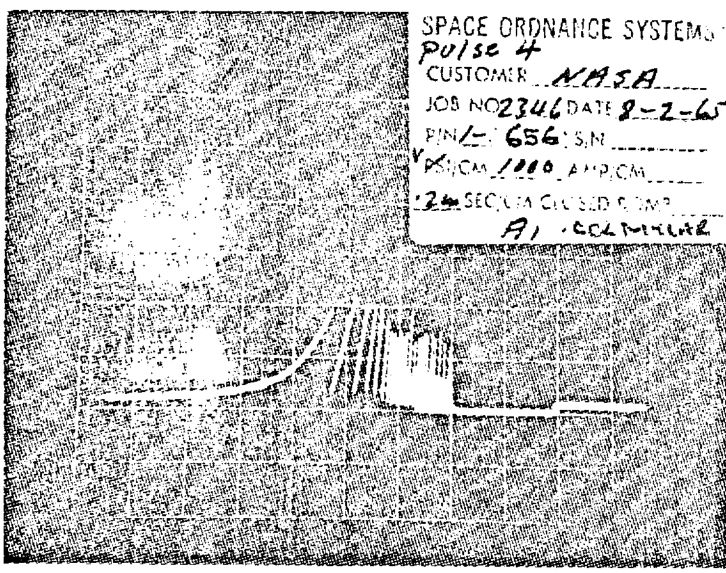

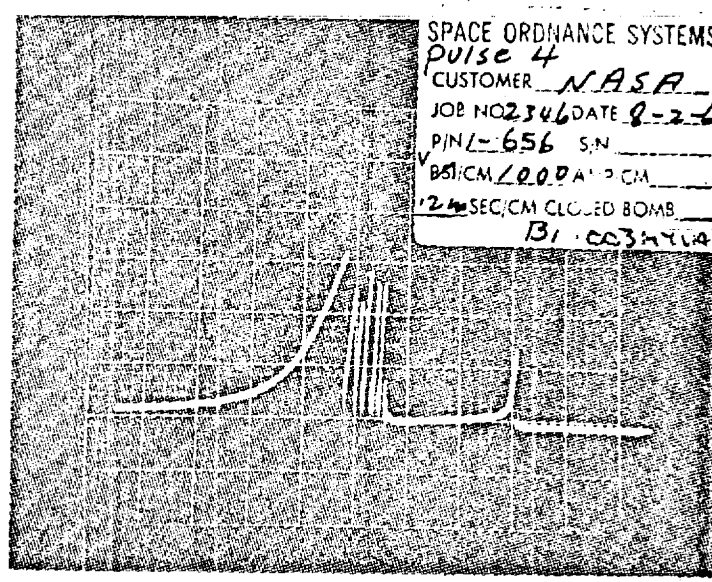

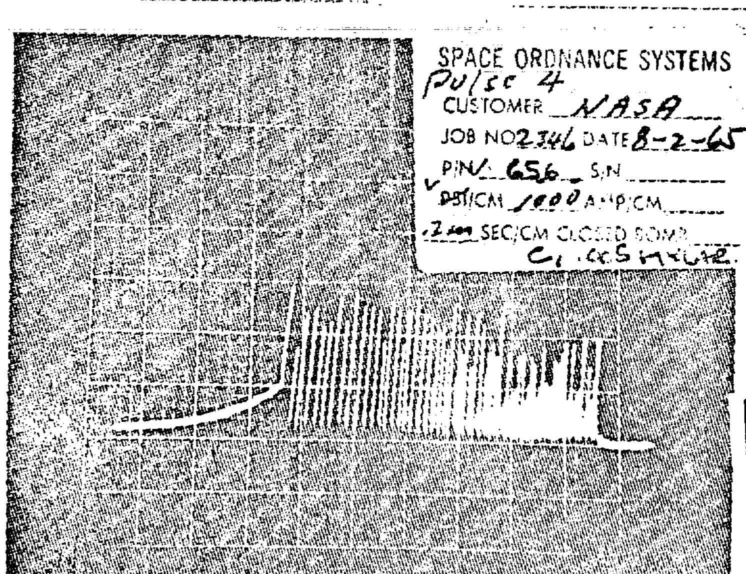

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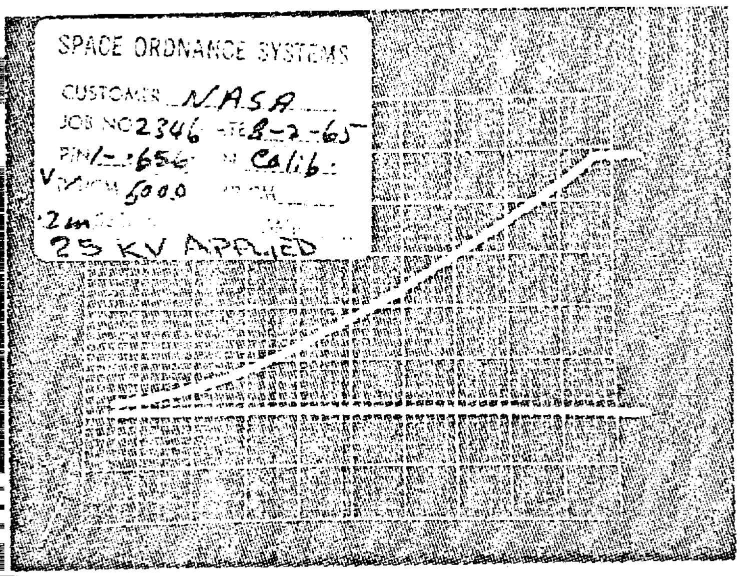

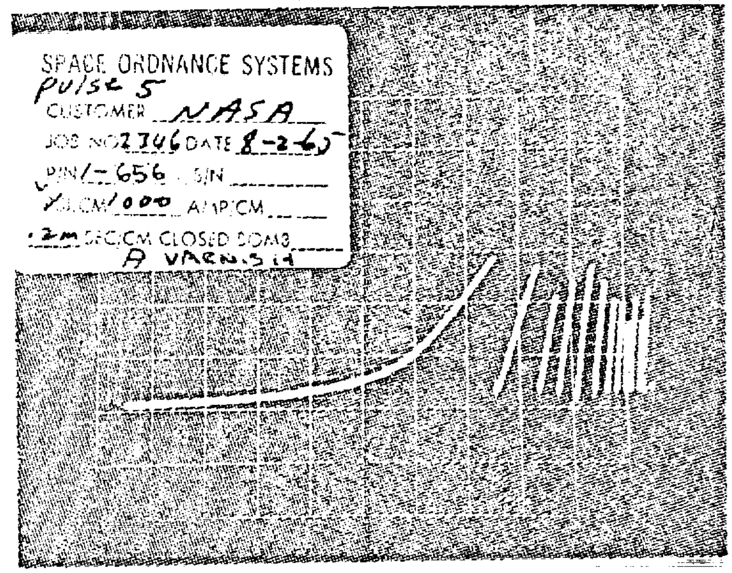

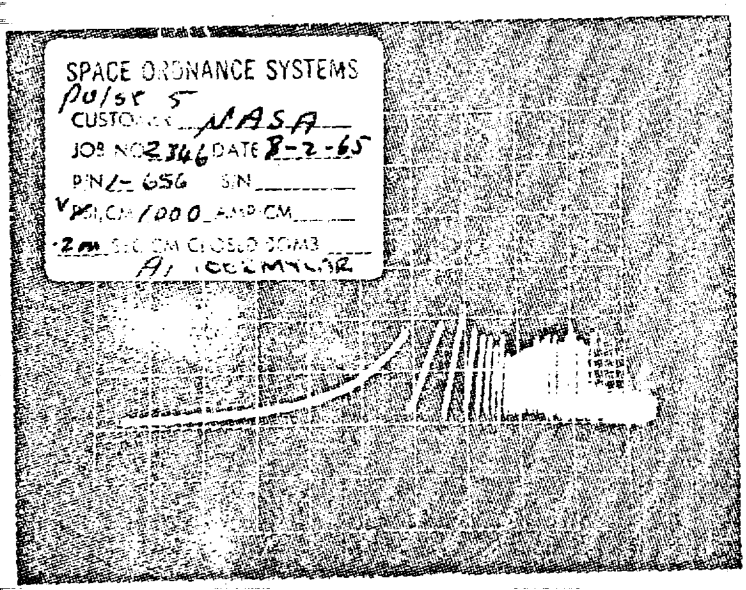

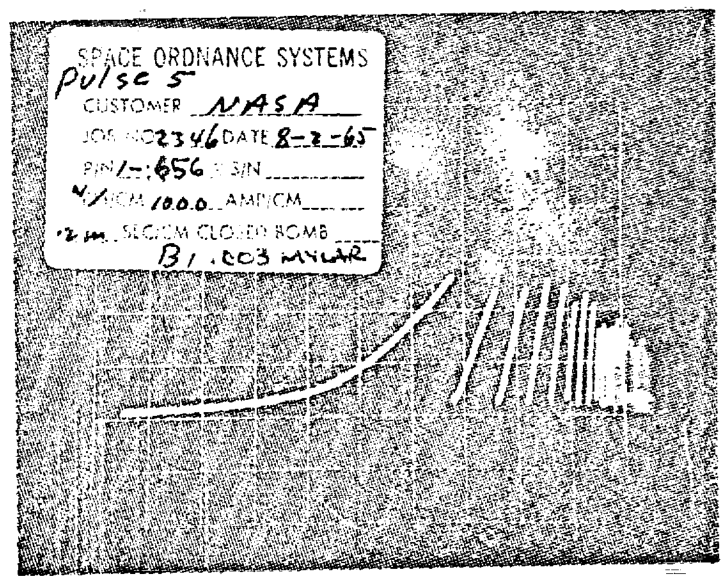

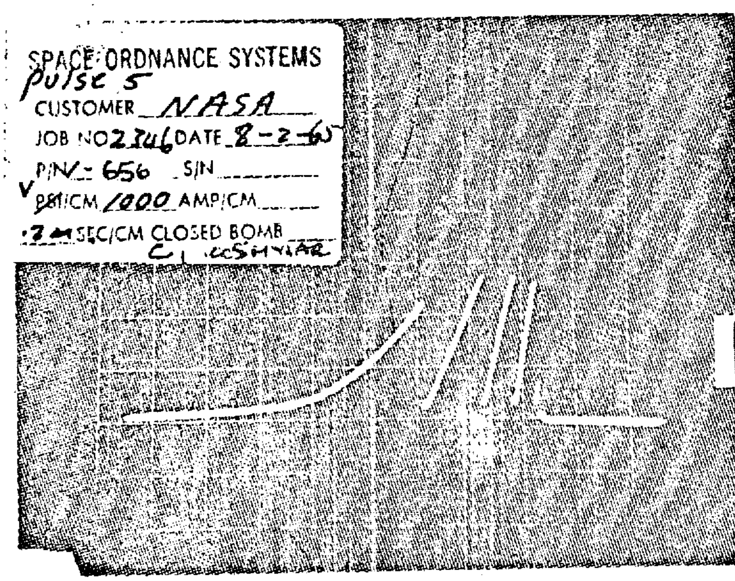

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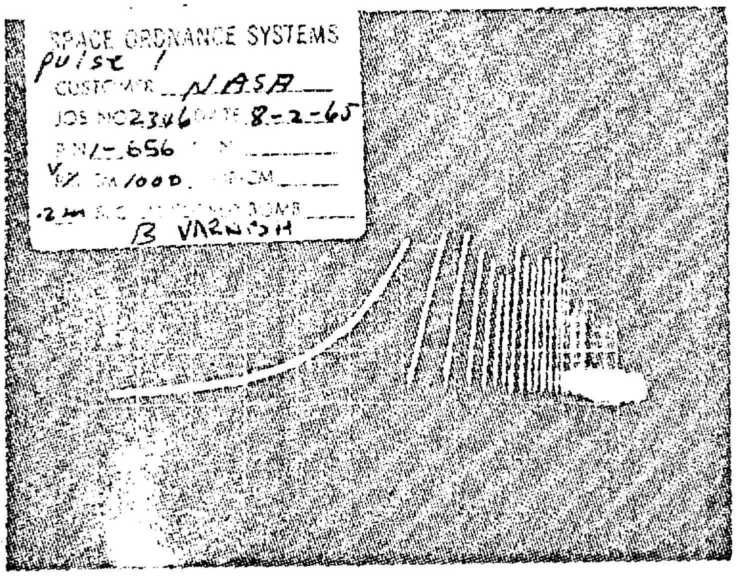

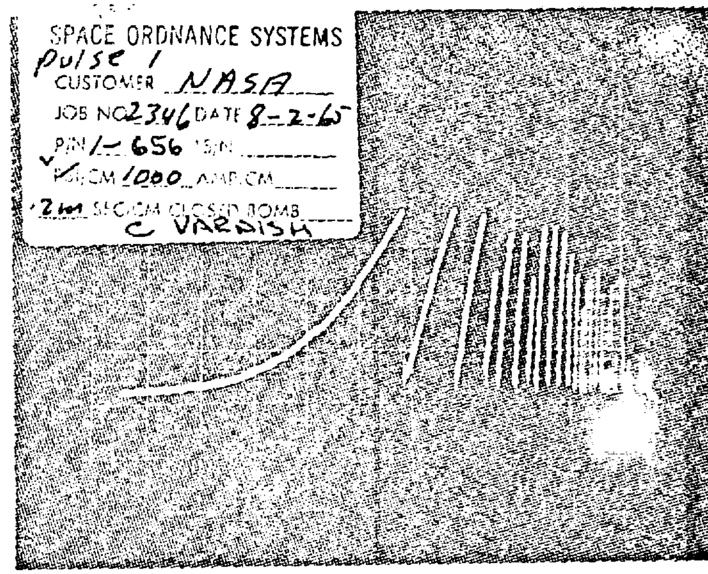

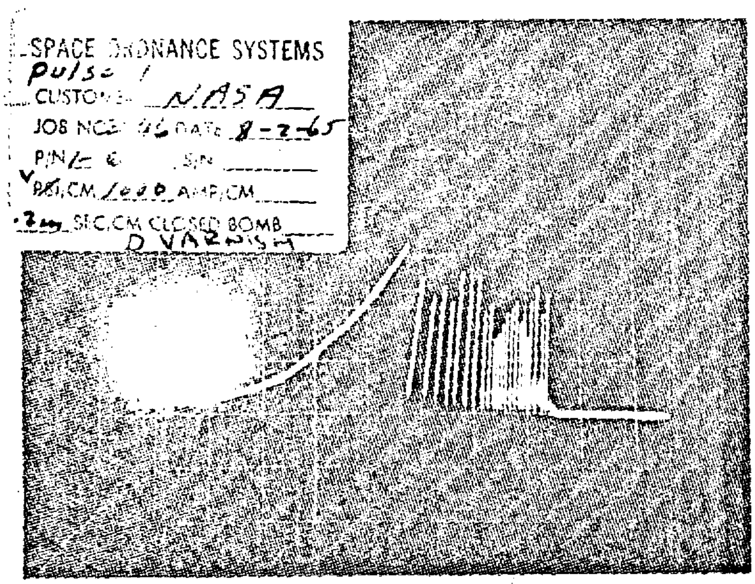

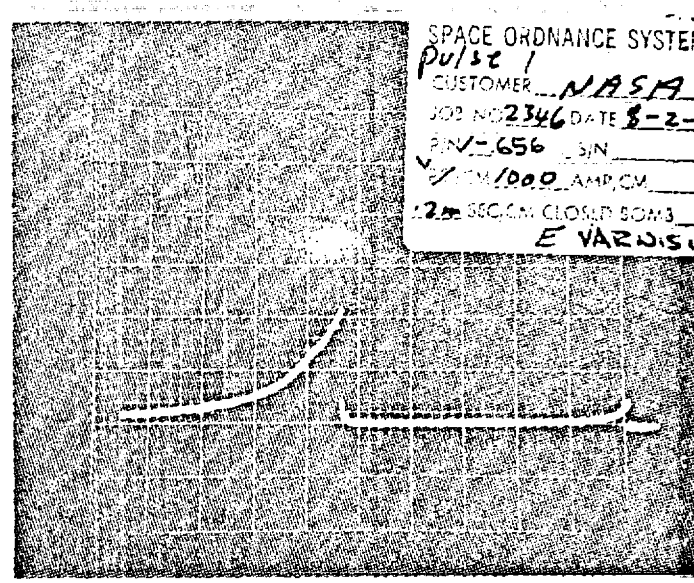

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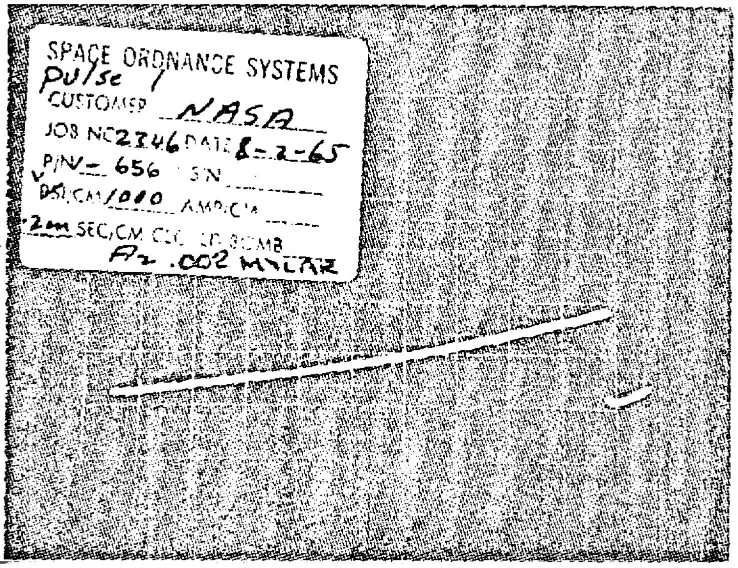

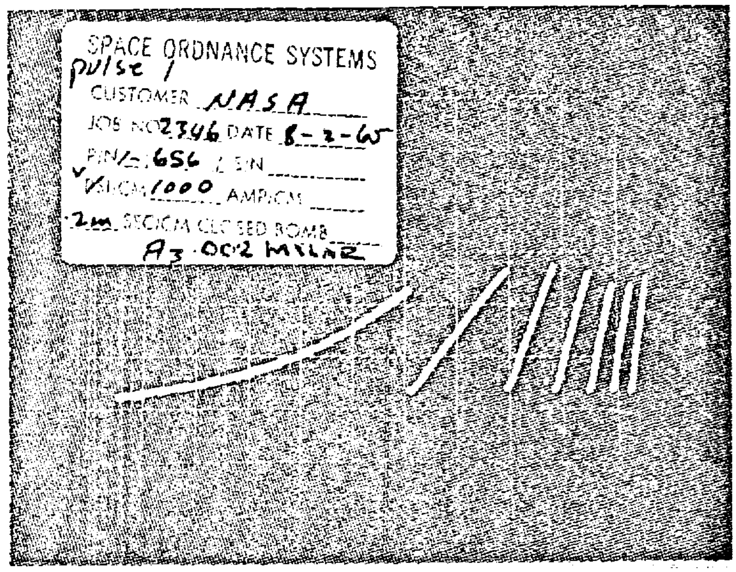

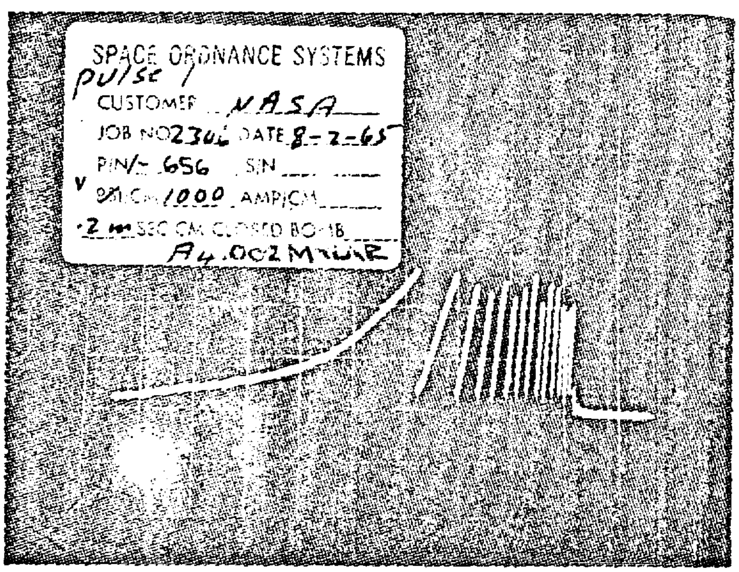

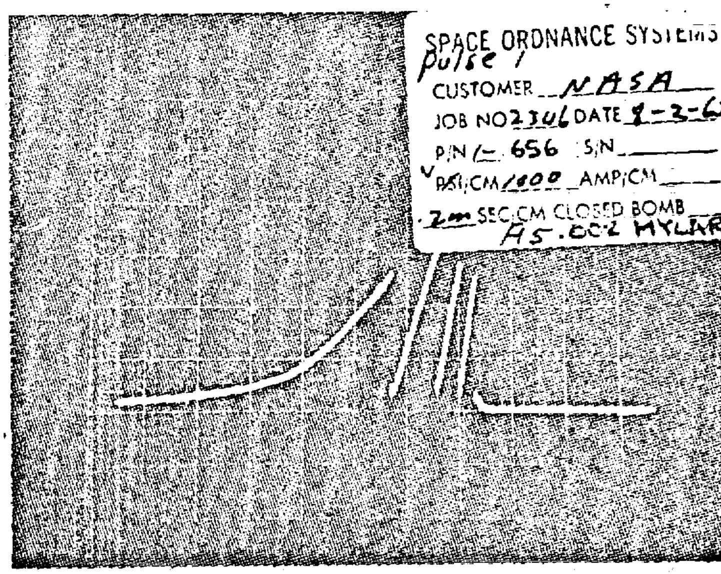

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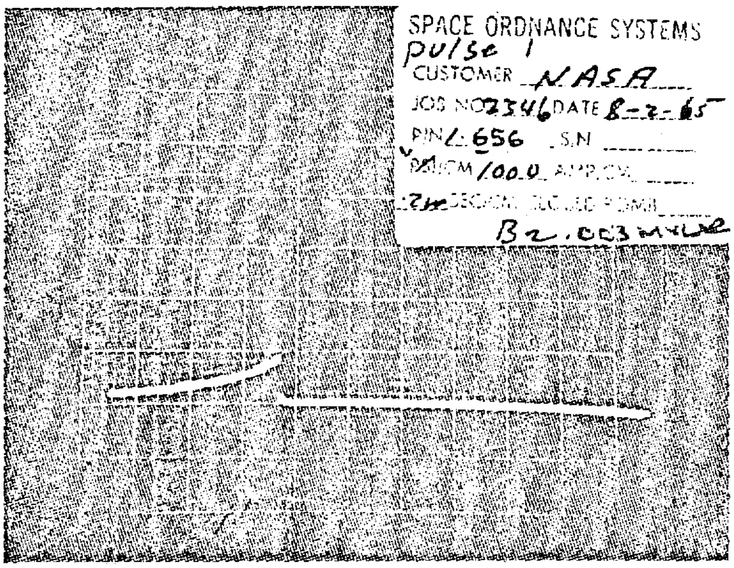

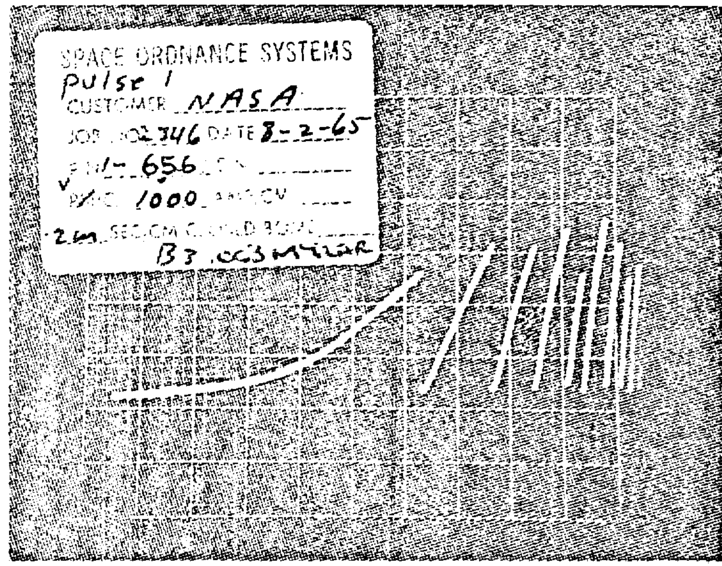

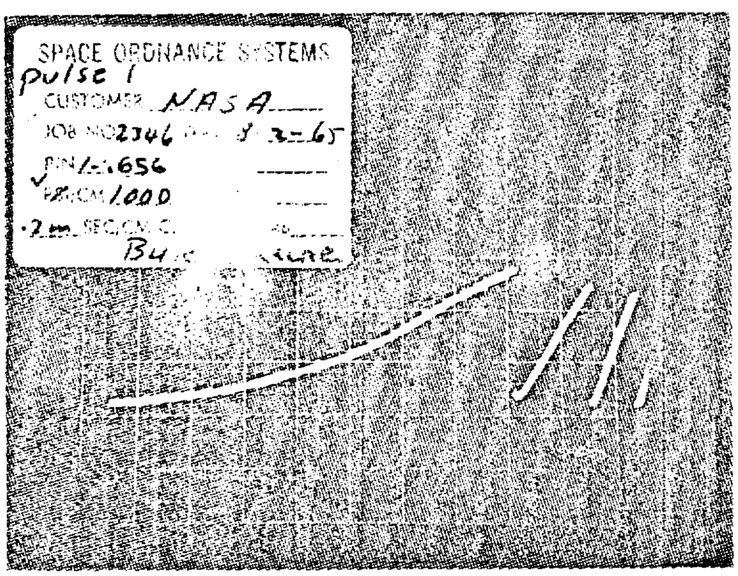

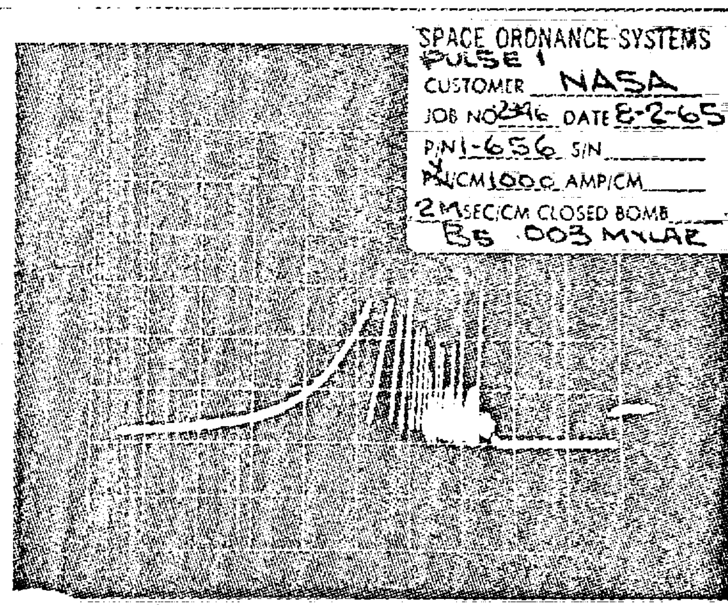

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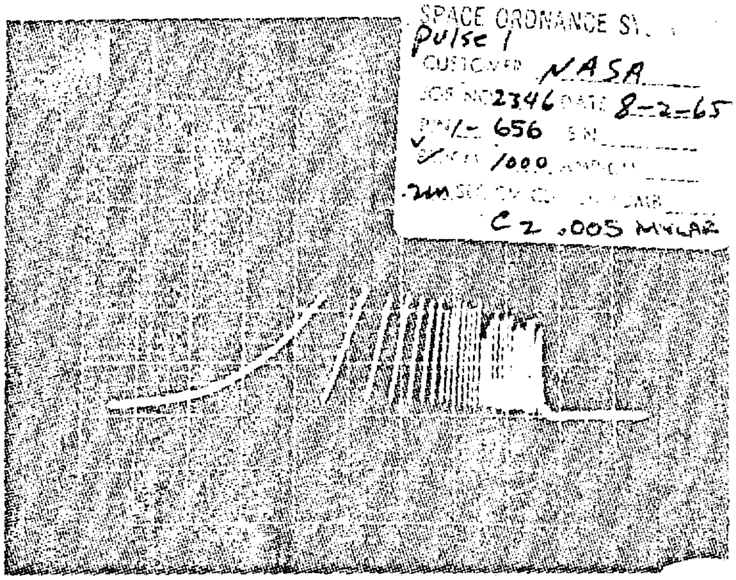

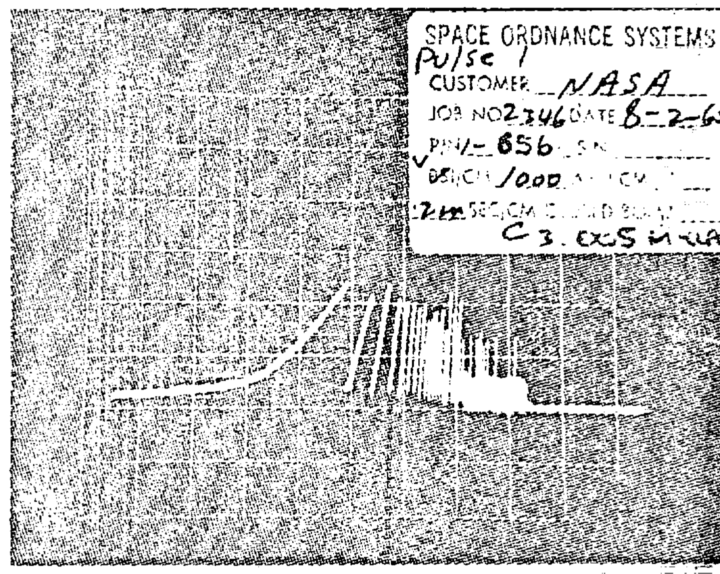

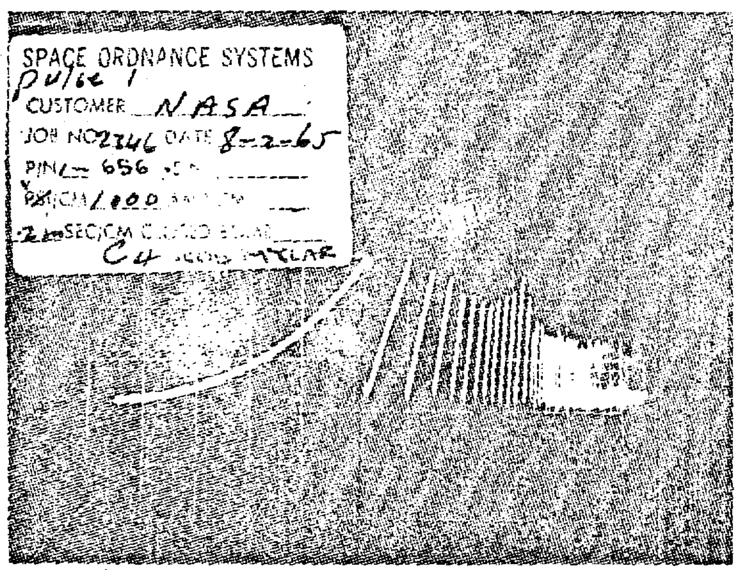

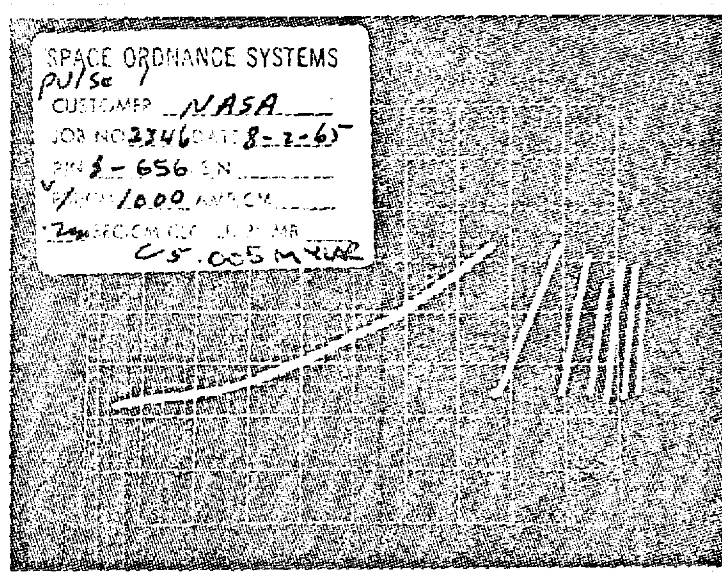

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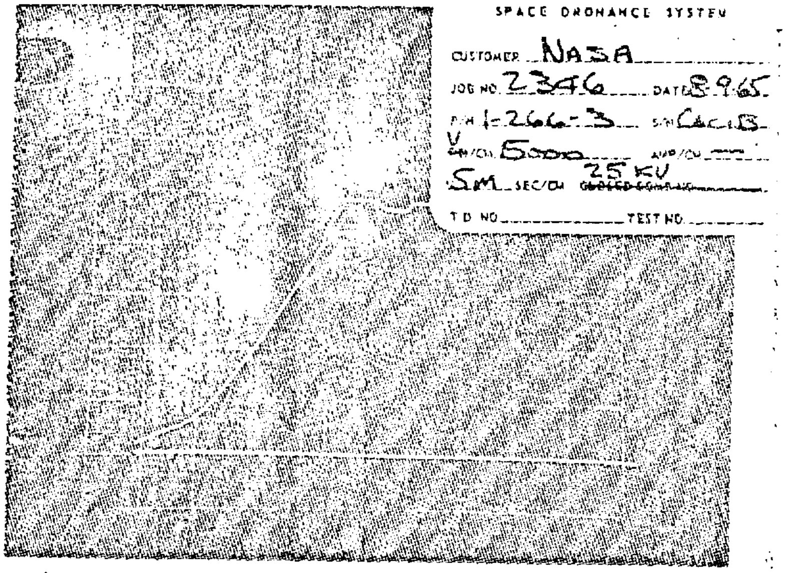
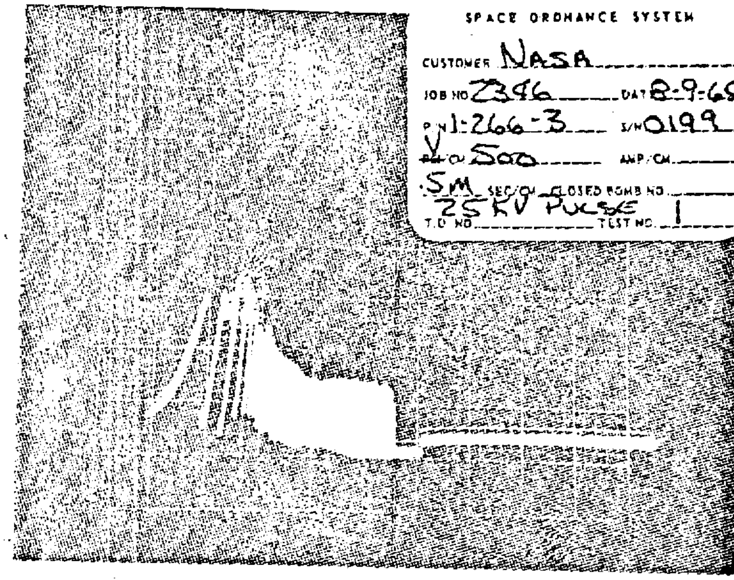
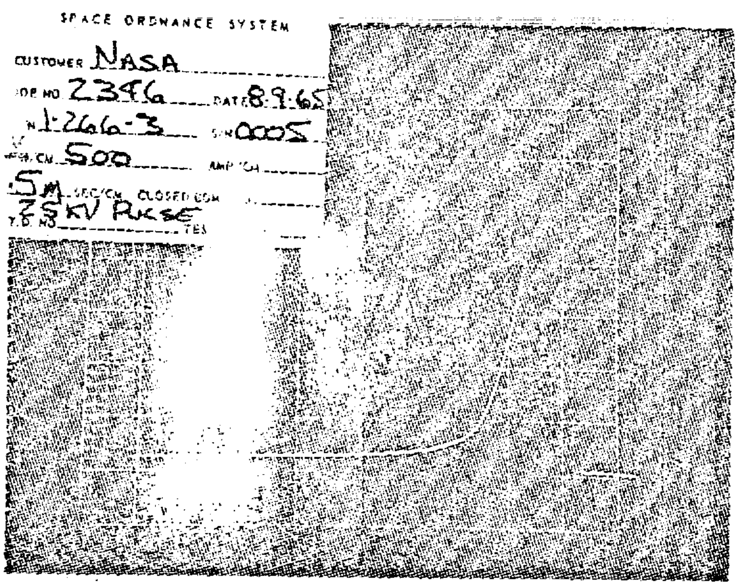
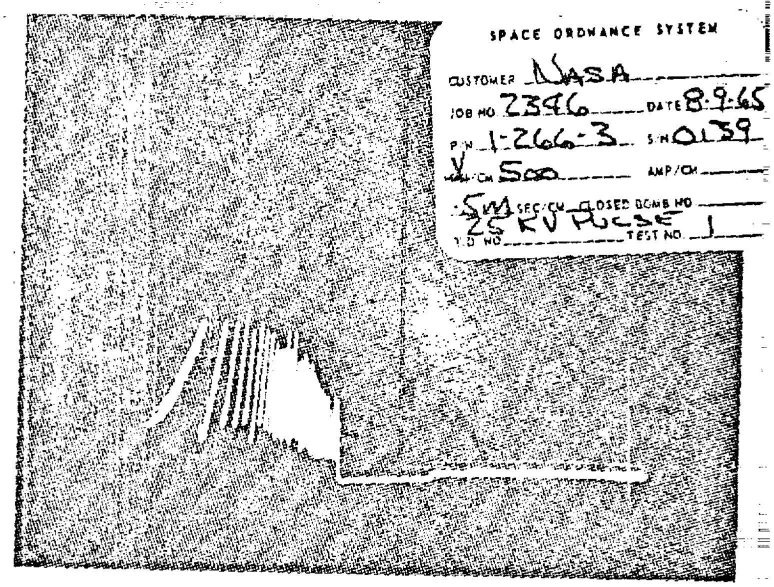








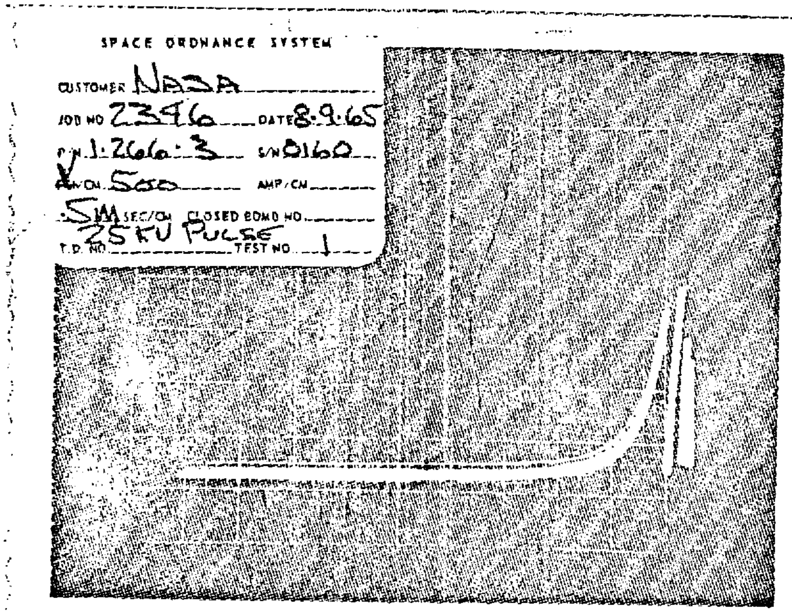
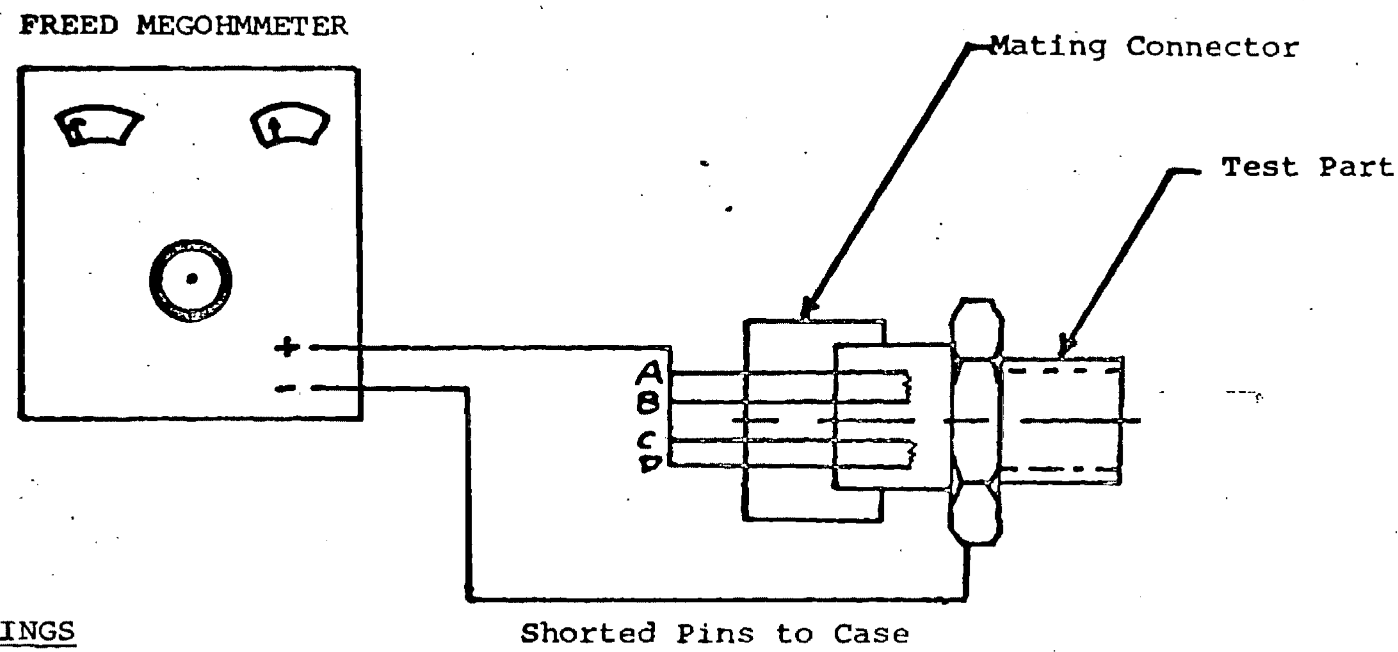


FIGURE I

INSULATION RESISTANCE TEST
SCHEMATIC



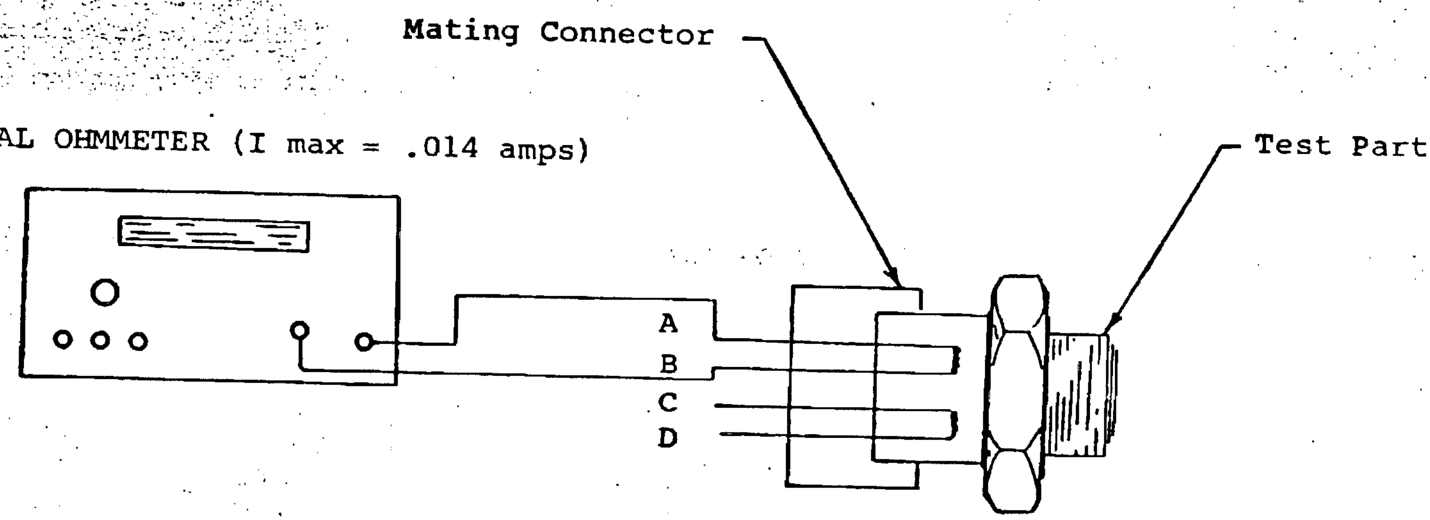
INSTRUMENT SETTINGS
MEGOHMMETER

500 vdc test voltage
Calibrate and zero adjust per manufacturer's operating manual prior to test.

FIGURE II

BRIDGEWIRE CIRCUIT RESISTANCE TEST
SCHEMATIC

CUBIC DIGITAL OHMMETER (I max = .014 amps)



INSTRUMENT SETTINGS

DIGITAL OHMMETER
Sensitivity Setting - 1
Power Switch - On

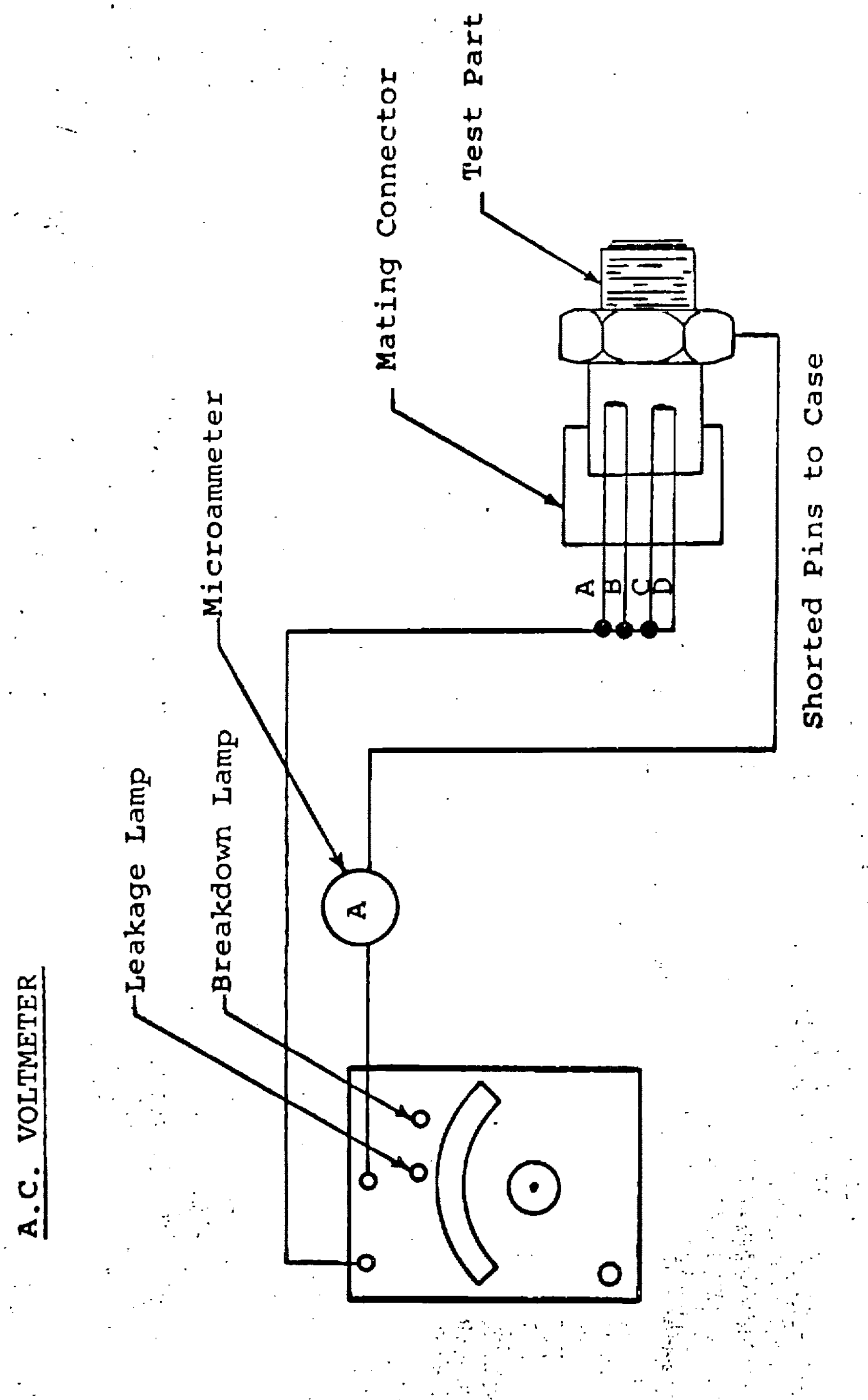


FIGURE III

DIELECTRIC STRENGTH

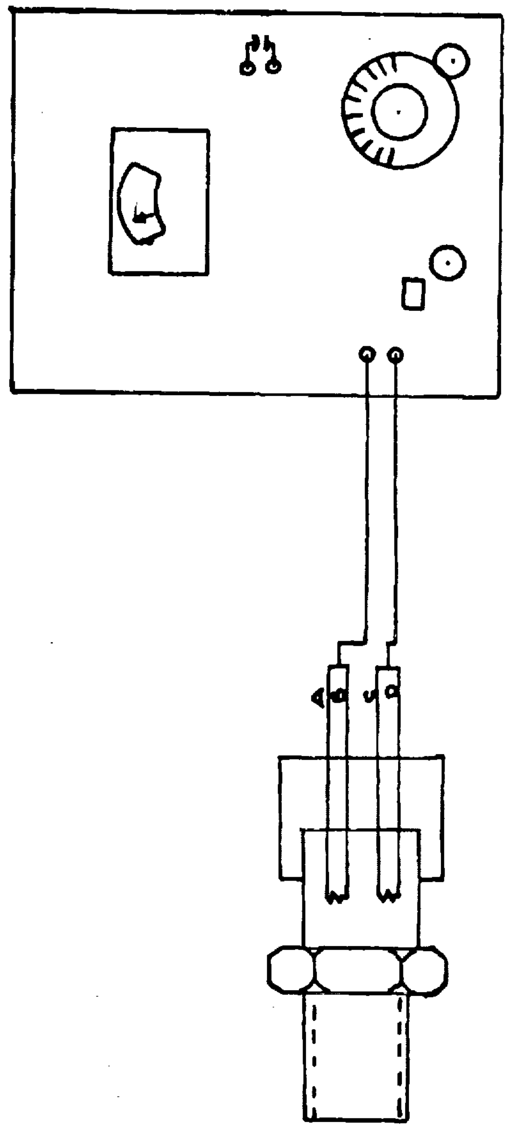


FIGURE IV

TEST SCHEMATIC
CAPACITANCE MEASURING
CIRCUIT TO CIRCUIT

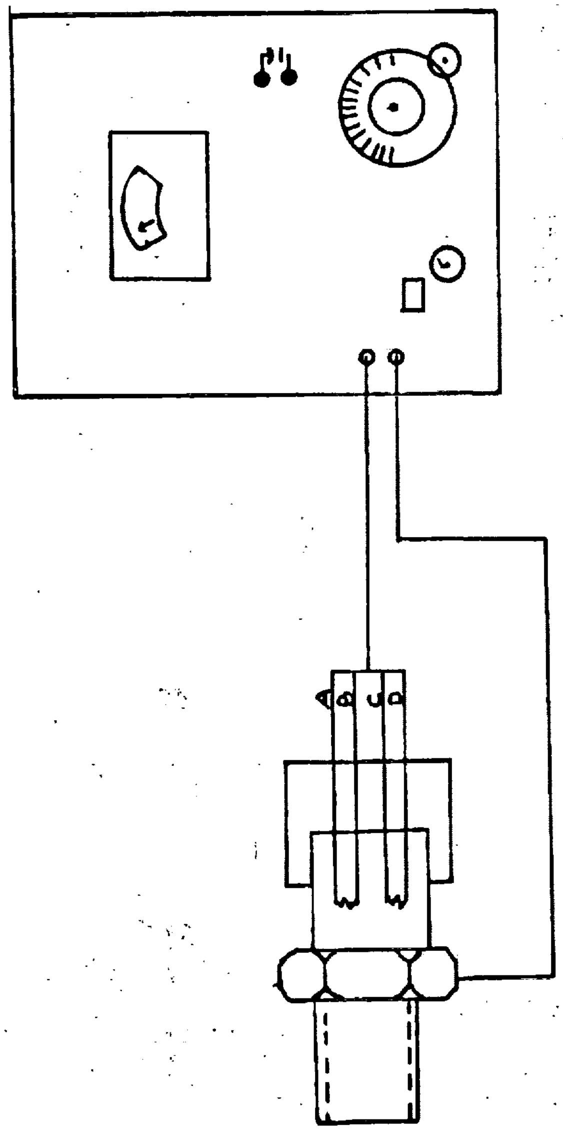


FIGURE V
TEST SCHEMATIC
CAPACITANCE MEASURING
SHORTED PINS TO CASE

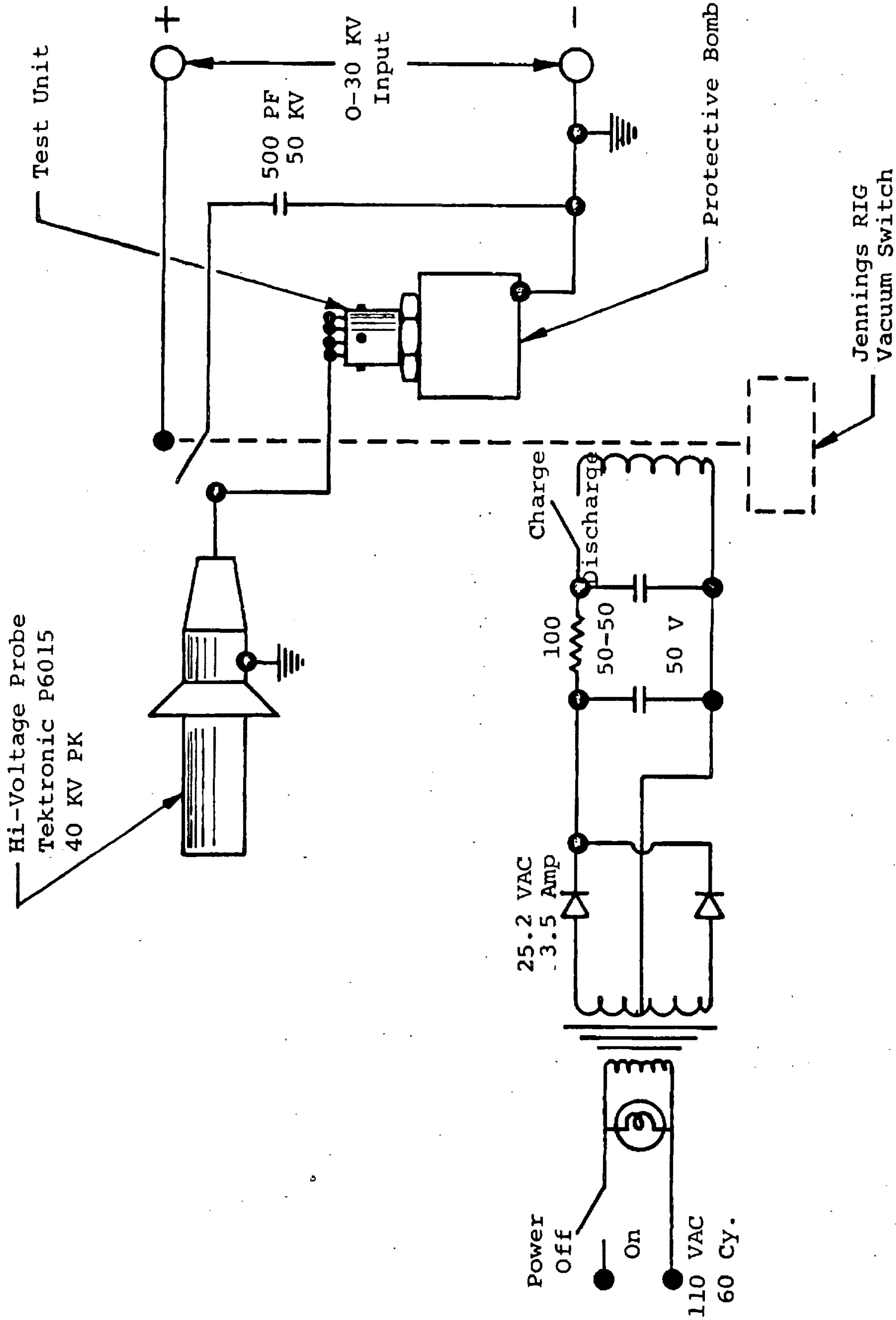
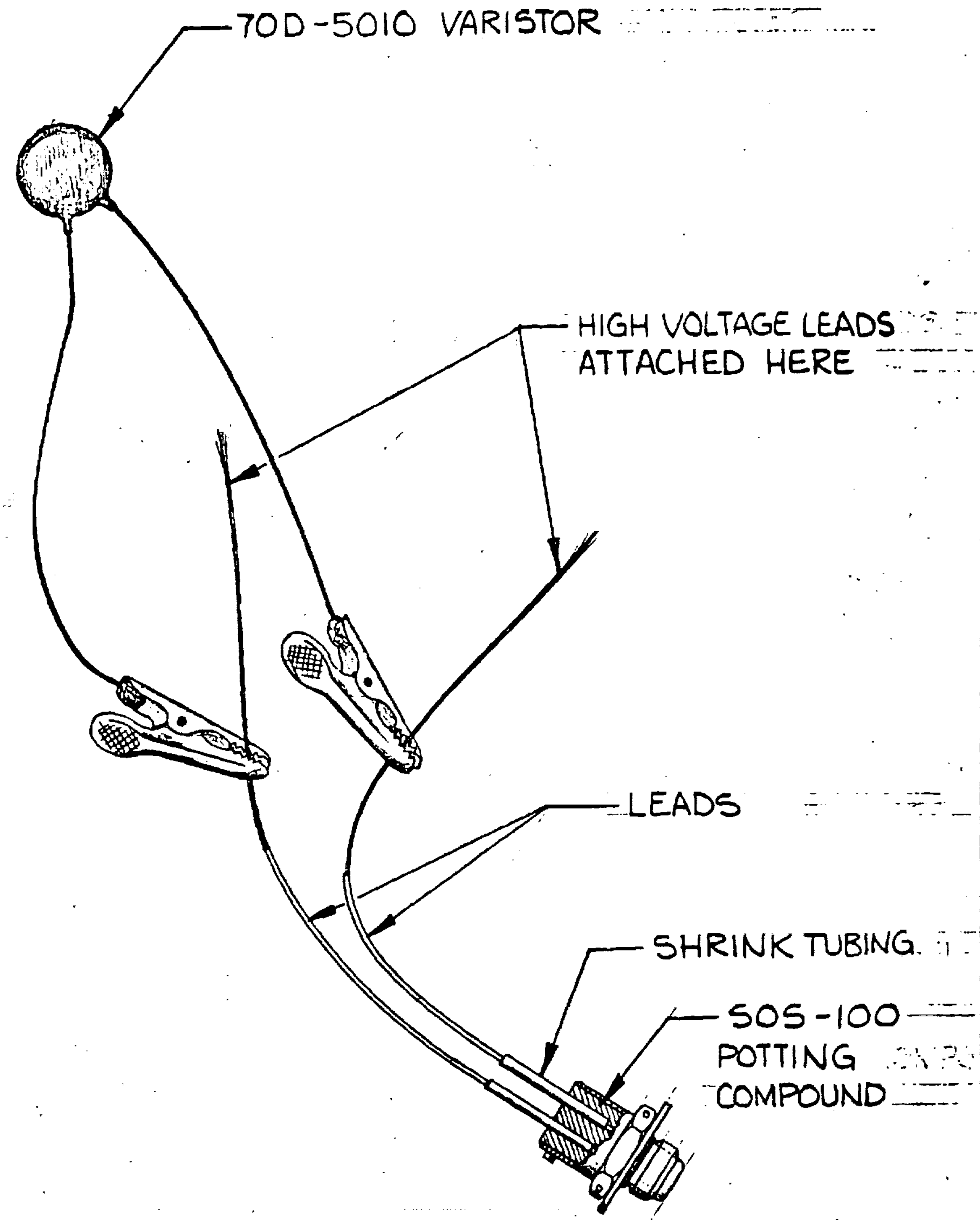


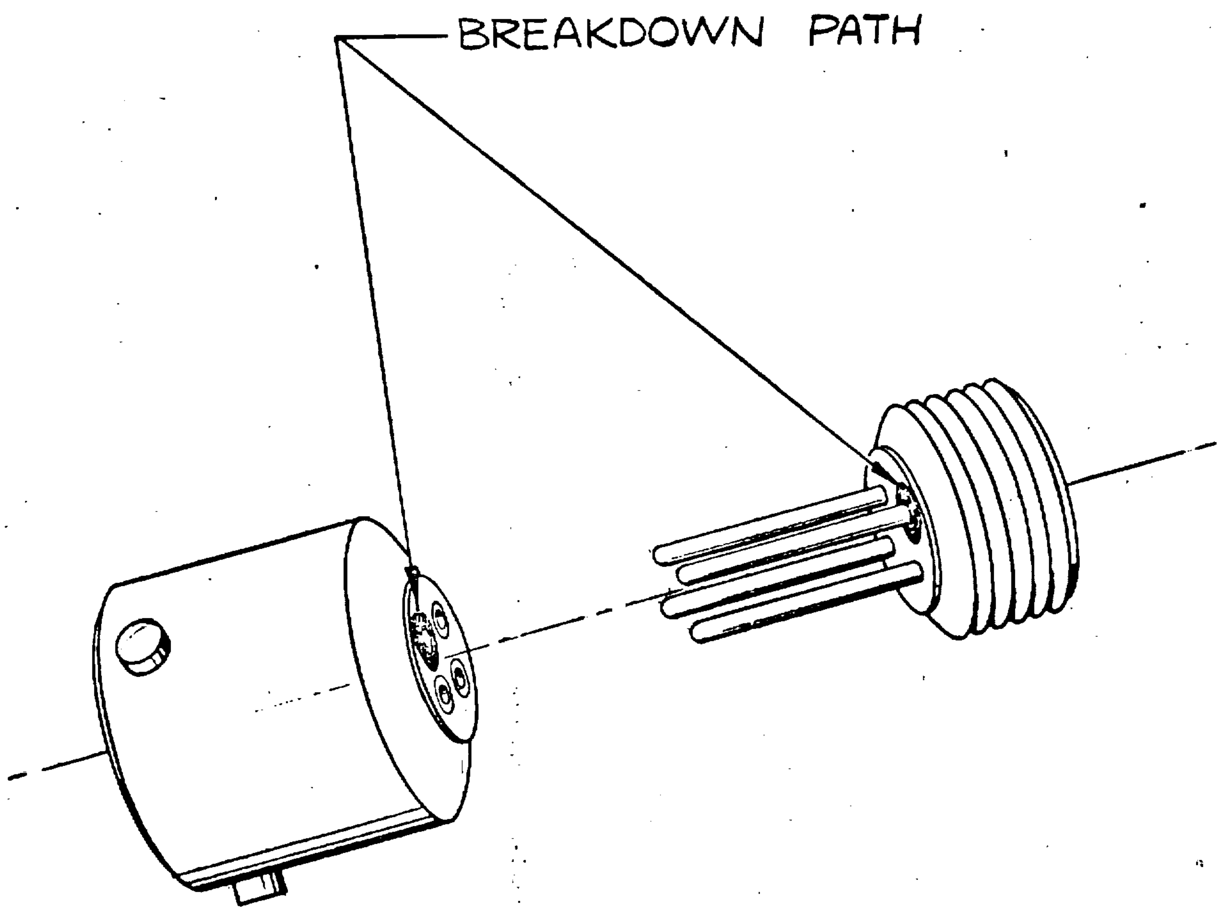
FIGURE VI

TEST - 0-30 KV CAPACITOR DISCHARGE

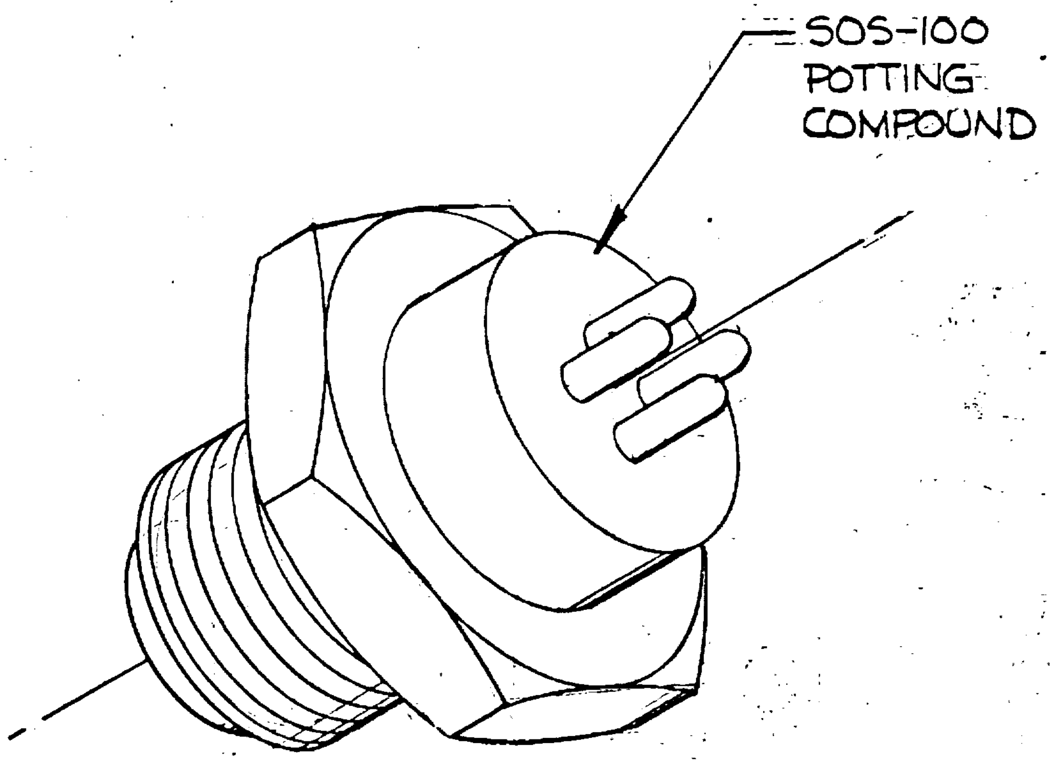


EADS ATTACHED ACCORDING TO TEST MODE THAT IS PIN A,
NS A TO B AND PINS A TO C.

MODE TEST ILLUSTRATION

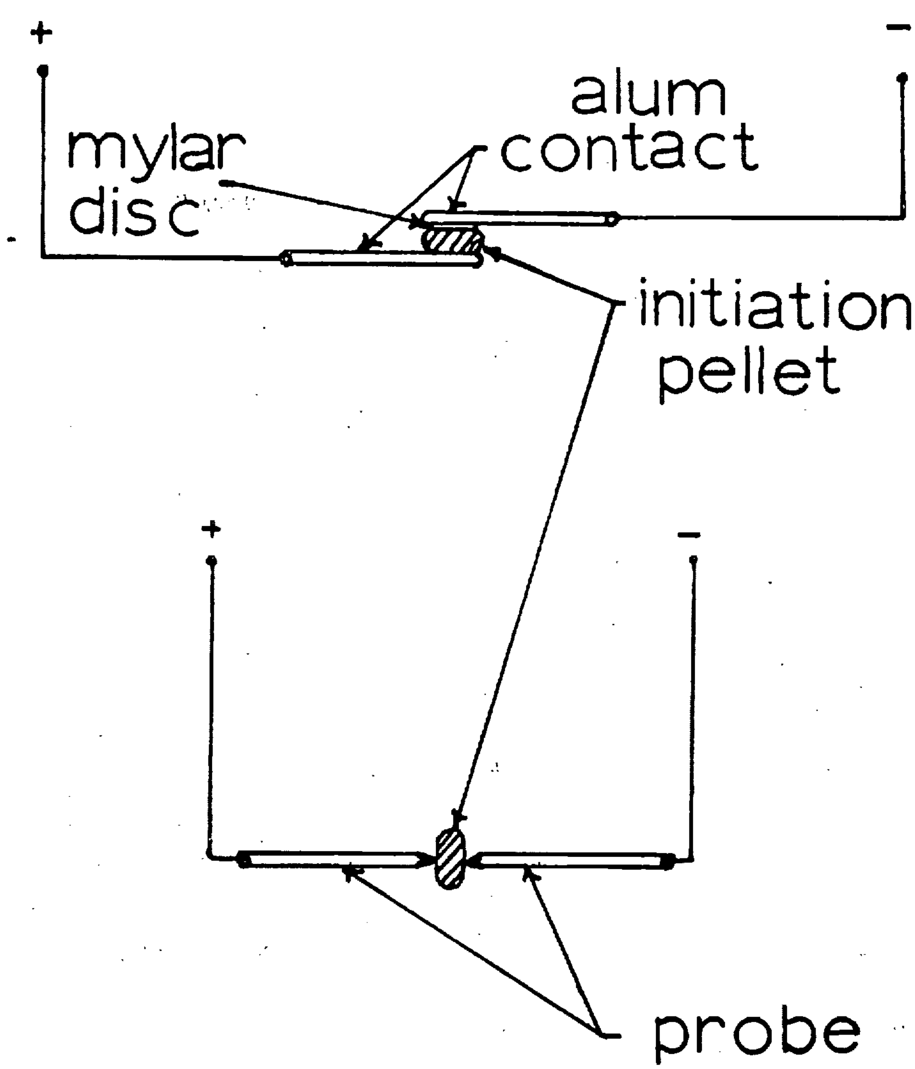


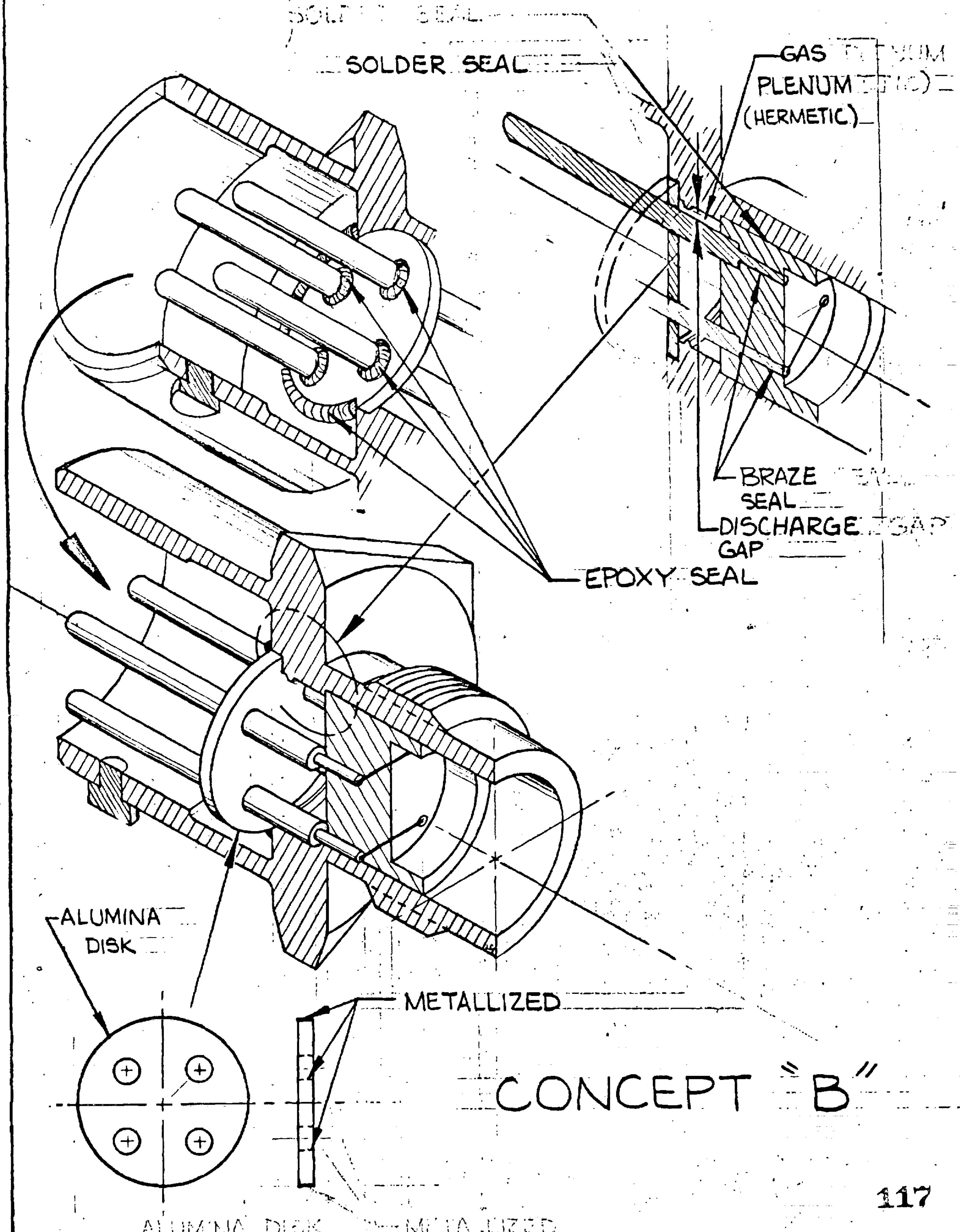
SERIAL NUMBER 0120 & 0118
DISSECTED UNITS



MODIFIED CONCEPT
CONFIGURATION

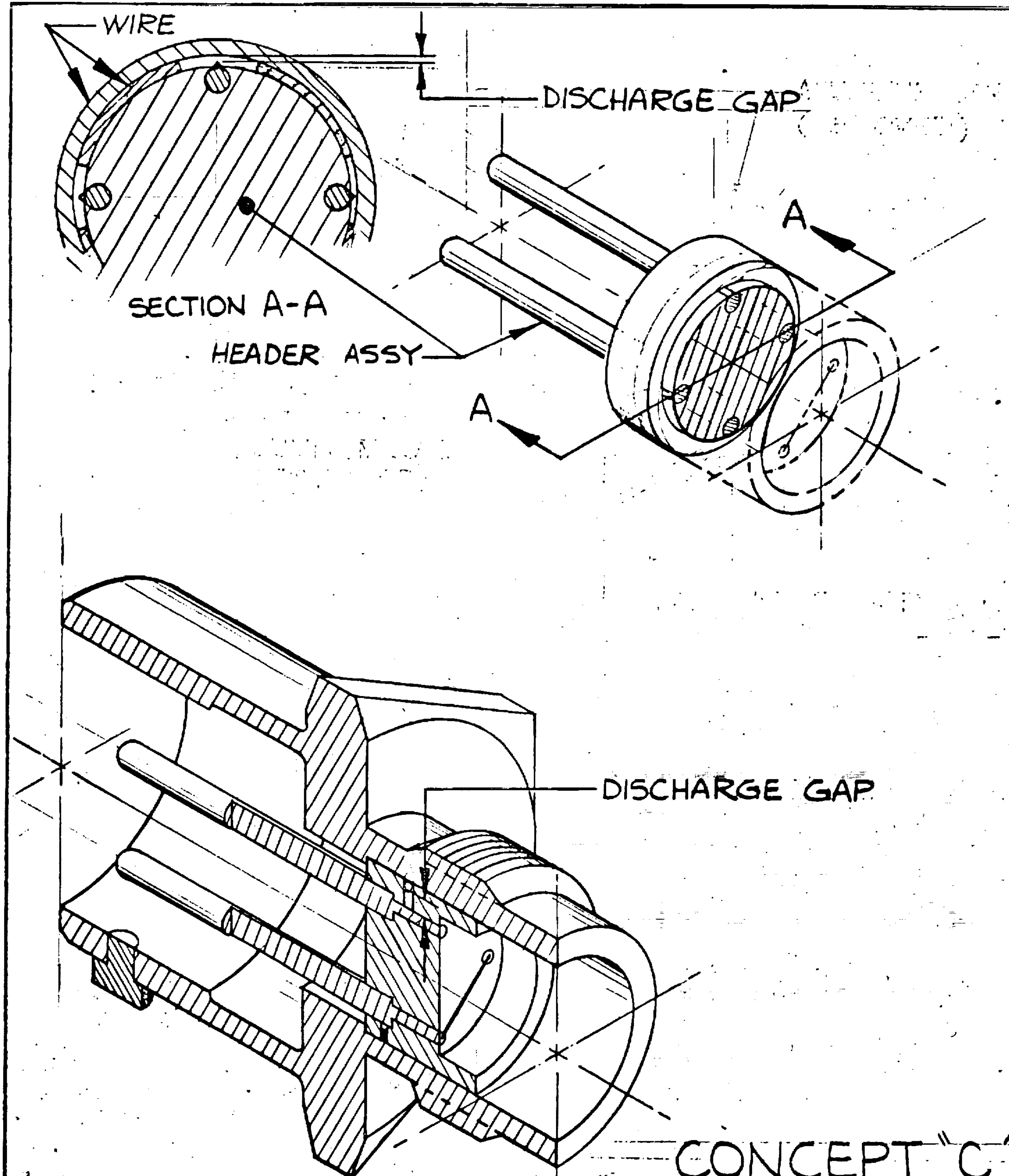
PELLET TEST SETUP



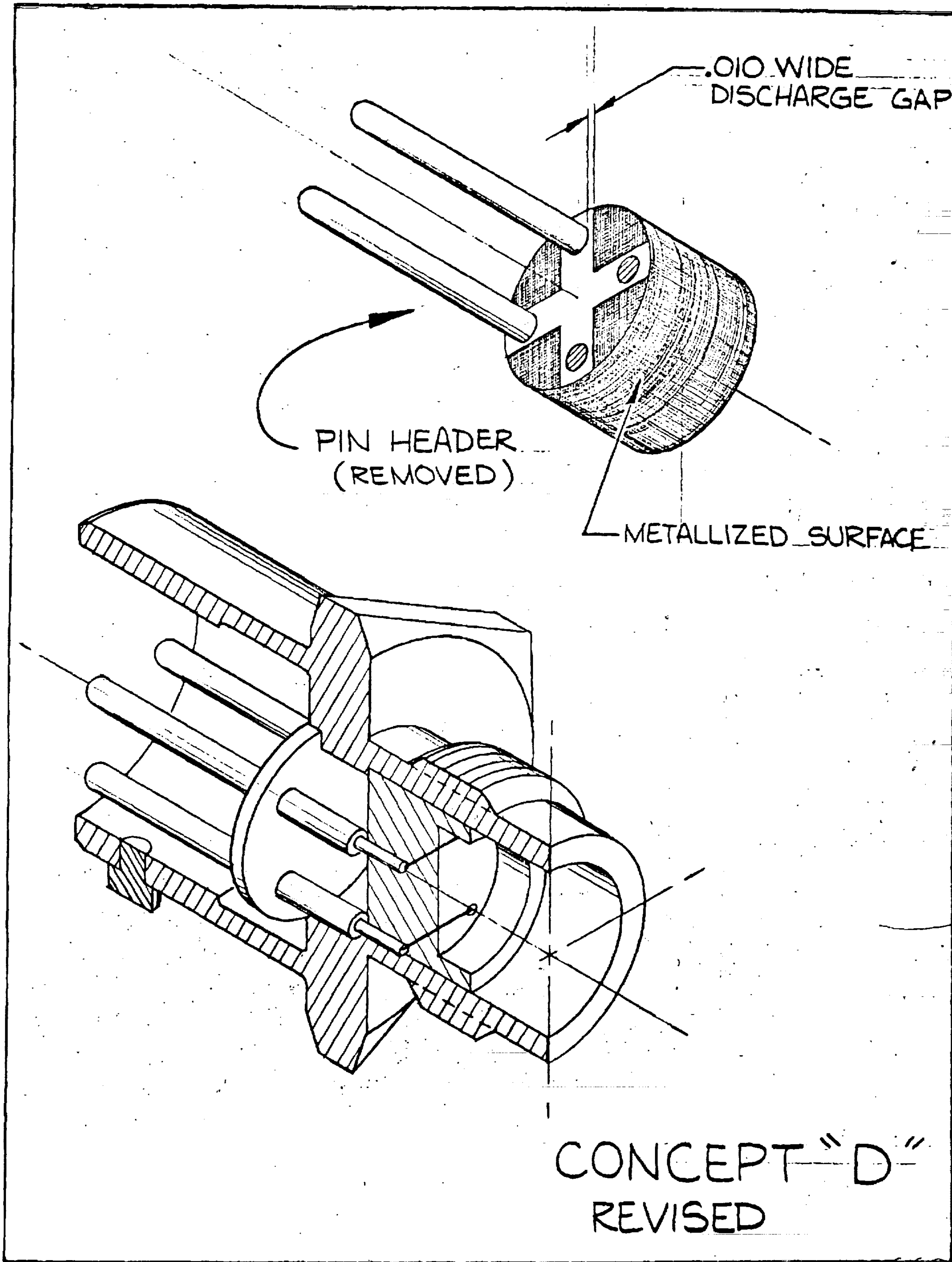


SOLDER SEAL
GAS PLENUM (HERMETIC)
BRAZE SEAL
DISCHARGE GAP
EPOXY SEAL
ALUMINA DISK
METALLIZED

CONCEPT "B"

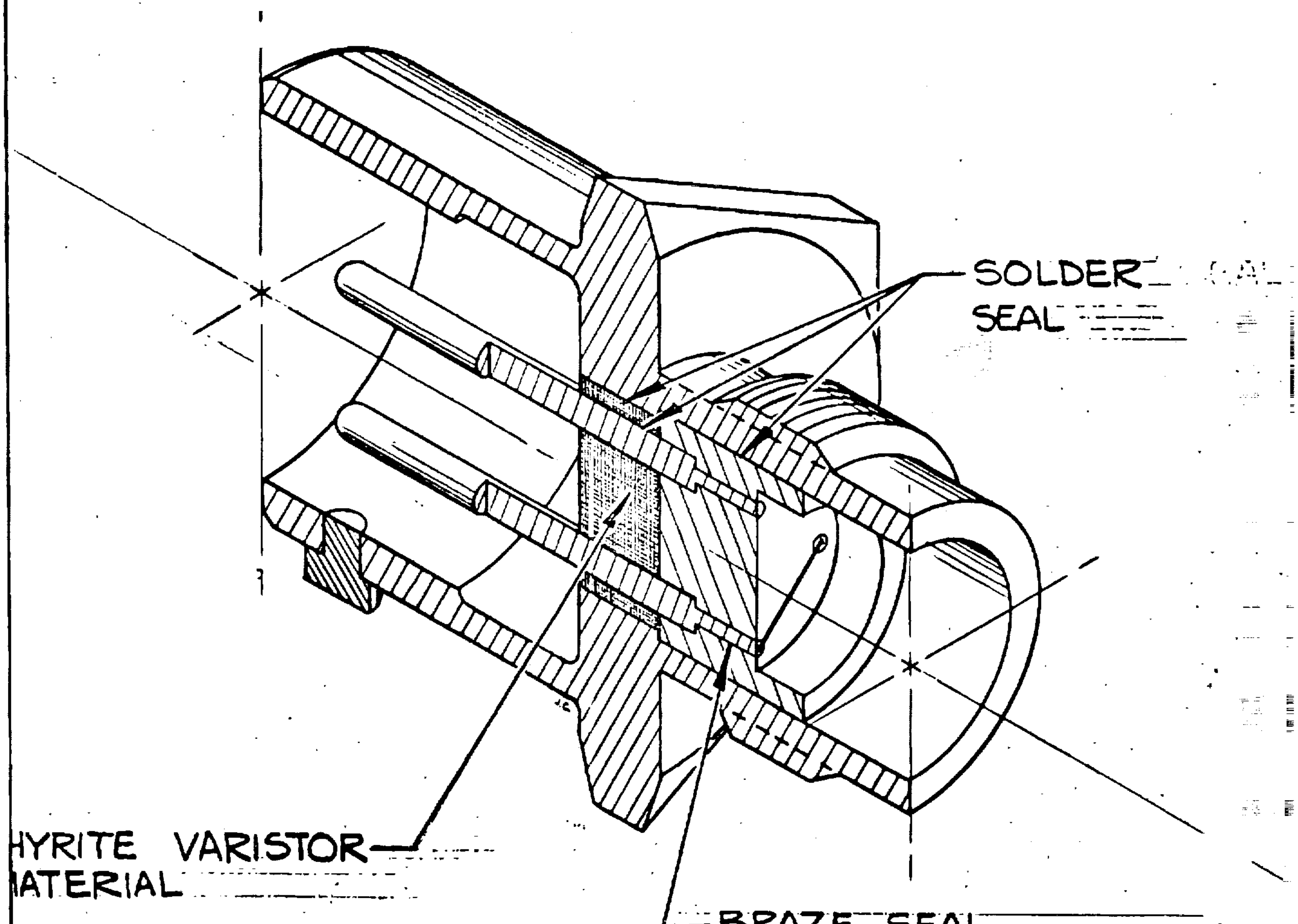


CONCEPT "C"
REVISED

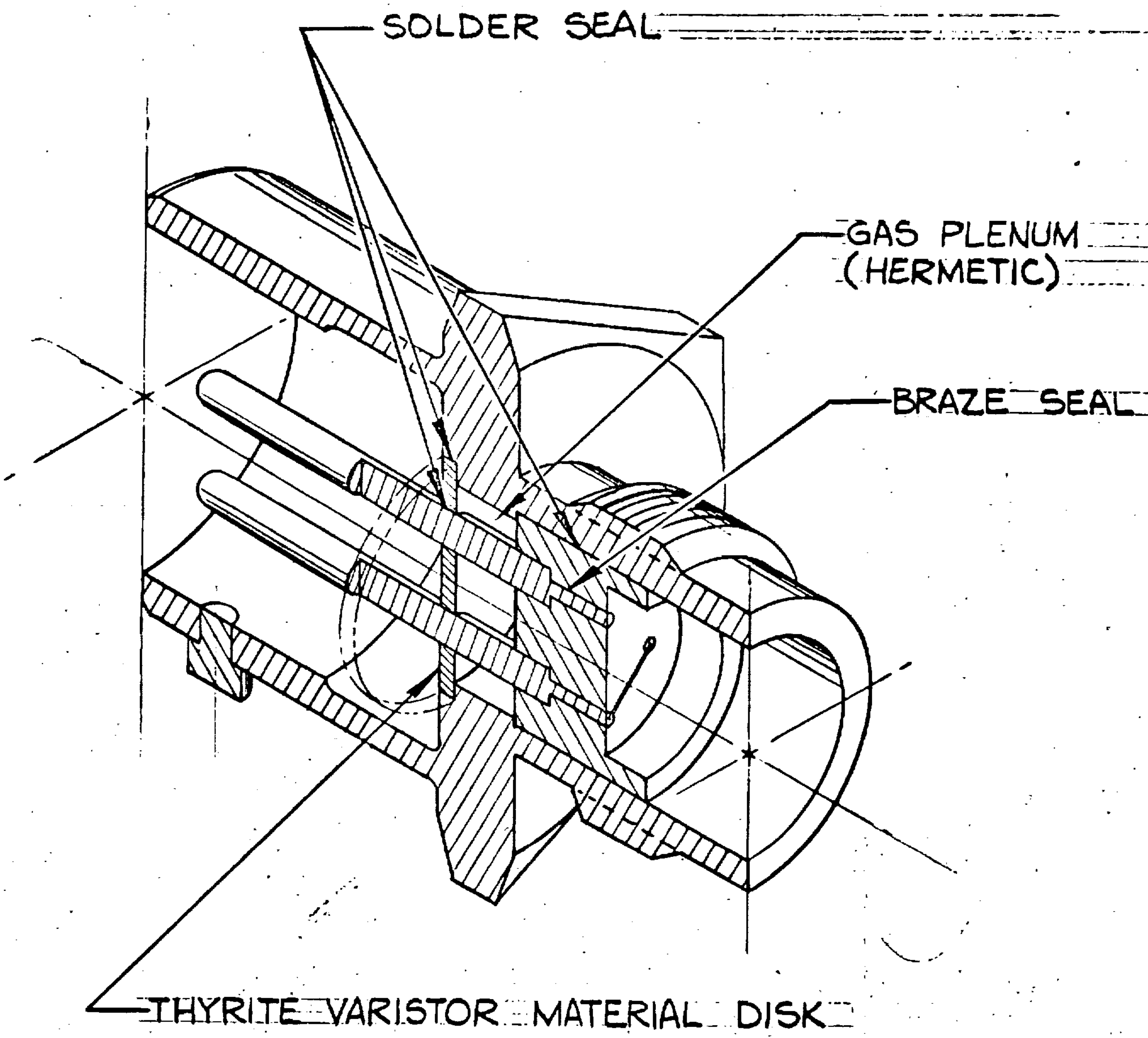

.010 WIDE DISCHARGE GAP
PIN HEADER (REMOVED)
METALLIZED SURFACE
CONCEPT "D" REVISED

SPACE ORDNANCE SYSTEMS, INC.

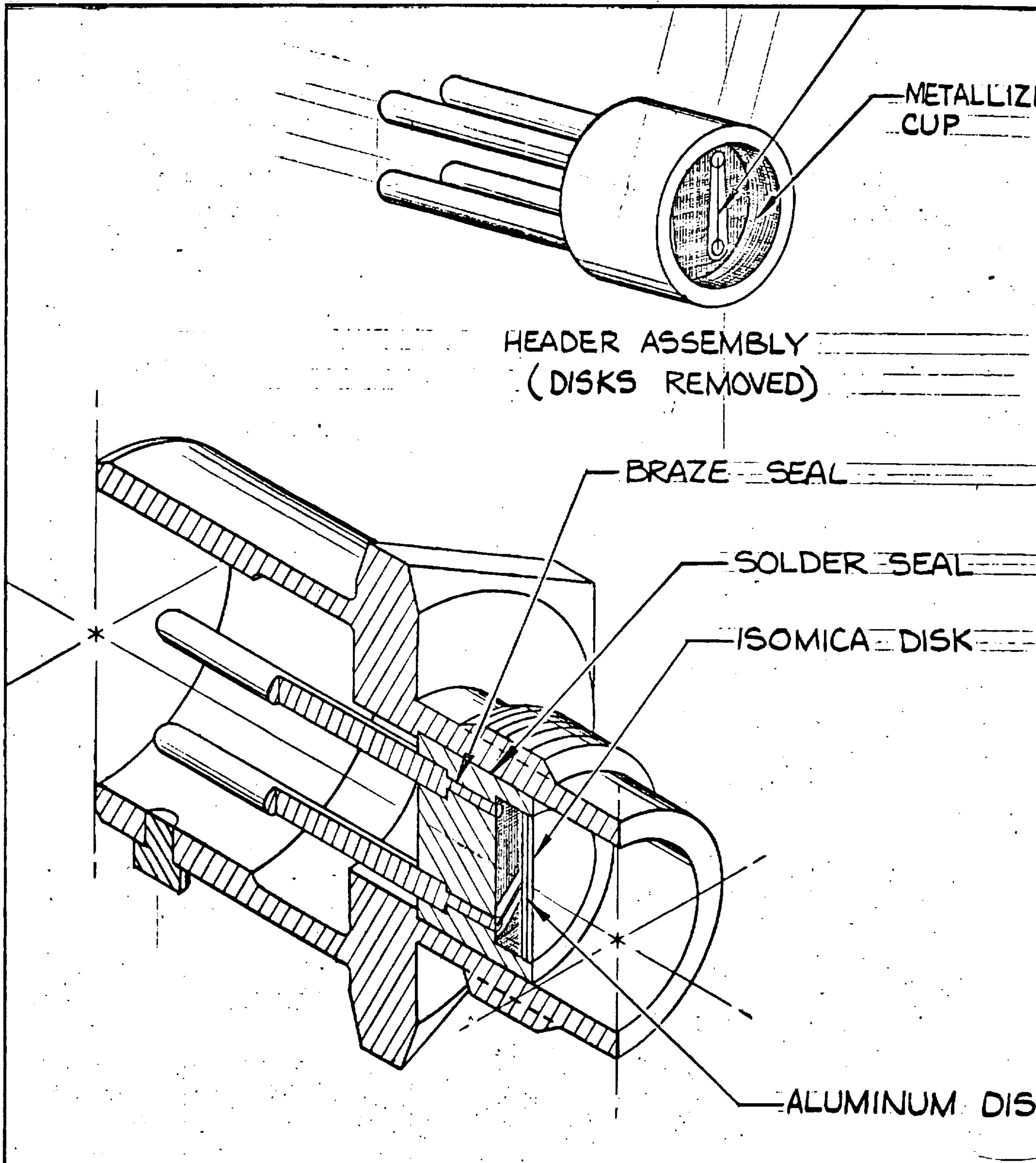
2346



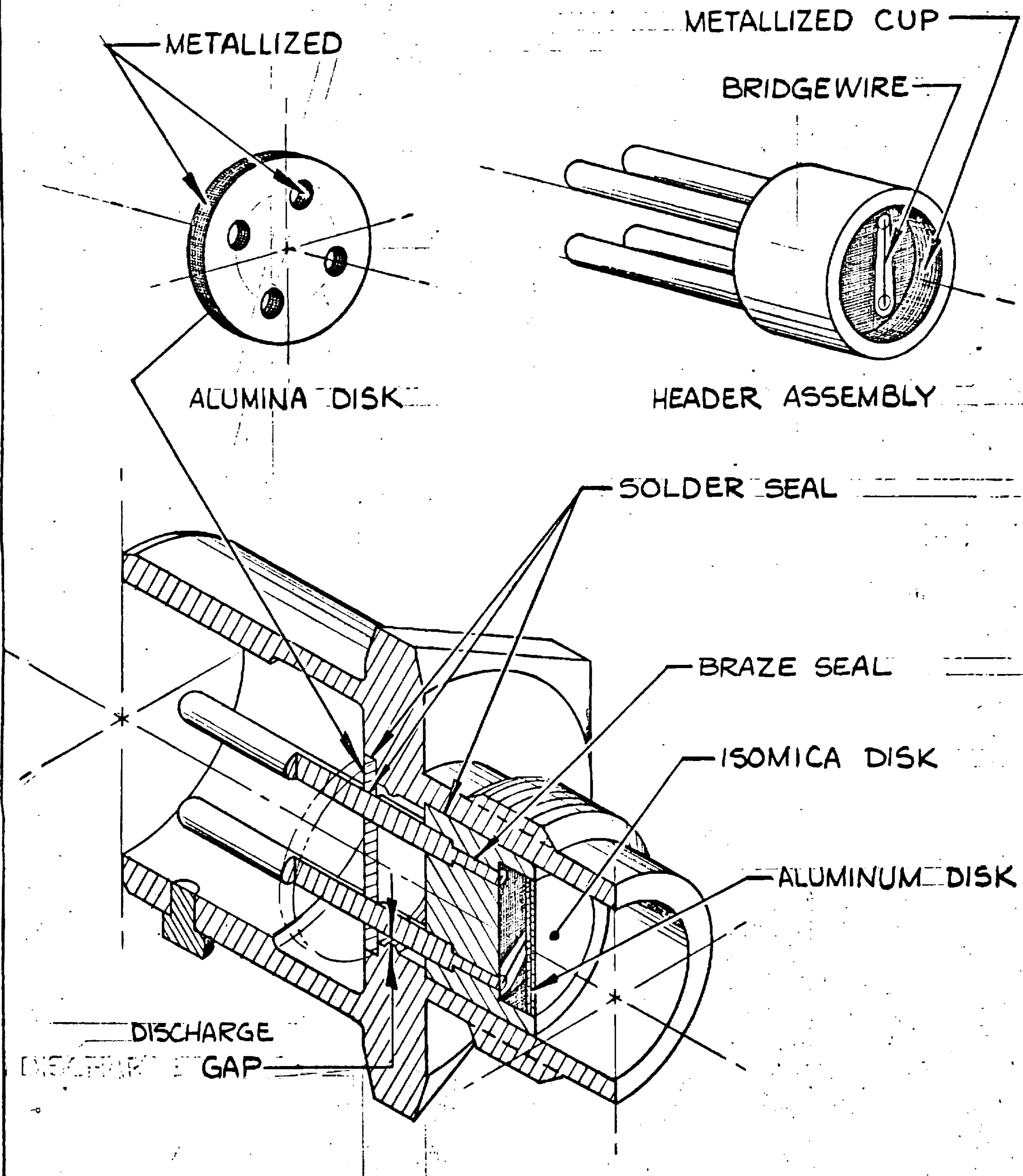
CONCEPT "E"


SOLDER SEAL
GAS PLENUM (HERMETIC)
BRAZE SEAL
THYRITE VARISTOR MATERIAL DISK

CONCEPT "F"


METALLIZE
CUP
HEADER ASSEMBLY
(DISKS REMOVED)
BRAZE SEAL
SOLDER SEAL
ISOMICA DISK
ALUMINUM DIS

CONCEPT "G"



CONCEPT "H"

CONCEPT "H"